PROCEEDINGS

AND

TRANSACTIONS

OF THE

LIVERPOOL BIOLOGICAL SOCIETY.

VOL. XII.

SESSION 1897-98.

PRICE—TWENTY-ONE SHILLINGS.

LIVERPOOL:
PRINTED BY T. DOBB & Co., 229, BROWNLOW HILL.

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ERRATA.

On p. 152, 2nd line from top, for "humerus" read "radius."

On p. 271, 3rd line from top, for "BRACYOCERA" read "BRACHYURA."

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II. TRANSACTIONS.

PROCEEDINGS

OF THE

LIVERPOOL BIOLOGICAL SOCIETY.

OFFICE-BEARERS AND COUNCIL.

Ex-Presidents:

1886—87 PROF. W. MITCHELL BANKS, M.D., F.R.C.S.
1887—88 J. J. DRYSDALE, M.D.
1888—89 PROF. W. A. HERDMAN, D.SC., F.R.S.E.
1889—90 PROF. W. A. HERDMAN, D.SC., F.R.S.E.
1890—91 T. J. MOORE, C.M.Z.S.
1891—92 T. J. MOORE, C.M Z.S., A.L.S.
1892—93 ALFRED O. WALKER, J.P., F.L.S.
1893—94 JOHN NEWTON, M.R.C.S.
1894—95 PROF. F. GOTCH, M.A., F.R.S.
1895—96 PROF. R. J. HARVEY GIBSON, M.A.
1896—97 HENRY O. FORBES, LL.D., F.Z.S.

SESSION XII., 1897-98.

President:

ISAAC C. THOMPSON, F.L.S., F.R.M.S.

Vice-Presidents:

HENRY C. BEASLEY.
PROF. W. A. HERDMAN, D.SC., F.R.S.

Hon: Treasurer:

T. C. RYLEY.

Hon. Librarian:

JAMES JOHNSTONE.

Hon. Secretary:

JOSEPH A. CLUBB, M.SC., (VICT.).

Council:

HENRY O. FORBES, LL.D., F.Z.S.
PROF. R. J. HARVEY GIBSON, M.A.
K. GROSSMAN, M.D.
W. J. HALLS.
REV L. de B. KLEIN, D.SC.
REV. T. S. LEA, M.A.
G. H. MORTON, F.G.S.
JOHN NEWTON, M.R.C.S.
C. RICKETTS, M.D.
W. E. SHARP.
PROF. SHERRINGTON, M.D., F.R.S.
A. O. WALKER, F.L.S.

REPORT of the COUNCIL.

DURING the Session 1897-98 there have been seven ordinary meetings and one field meeting of the Society. The latter was once more held at Hilbre Island, and a very enjoyable afternoon was spent in searching the rocks and rock-pools at low water.

The communications made to the Society have been representative of almost all branches of Biology, and the exhibition of microscopic preparations and other objects of interest has been a prominent feature of the meetings.

On the invitation of the Council, Dr. W. H. Gaskell, F.R.S., from Cambridge, lectured before the Society at the April meeting, and chose as his subject "The Lamprey and its Transformation," under which title the Society had the privilege of hearing an account of Dr. Gaskell's important work on the origin of the Vertebrates.

The Council record with deep regret the death of one of the life-members, Dr. C. Herbert Hurst, formerly of Manchester, lately of Dublin. Dr. Hurst was at one time an active member of the Society, and contributed vigorously to the interesting discussions at the meetings. His important paper on "A new Theory of Hearing" was published in our ninth volume.

The Library continues to make satisfactory progress, and additional important exchanges have been arranged during the year.

The Treasurer's usual statement and balance sheet are appended.

No alterations have been made in the Laws of the Society during the past session.

The members at present on the roll are as follows :—

Honorary Members	9
Ordinary Members	64
Student Members............	17
Total	90

SUMMARY of PROCEEDINGS at the MEETINGS.

The first meeting of the twelfth session was held at University College on Friday, October 15th, 1897.

1. The following exhibits were on view in the Zoological Laboratory from 7 to 7-30.

   A series of photographs illustrating animal and plant life taken between tide marks at Port Erin, by the Rev. T. S. Lea.

   Mounted preparations of Crustacean appendages by Mr. A. Scott.

   A series of prehistoric implements from northern Italy, by Dr. de Beaumont Klein.

The President-elect (I. C. Thompson, F.L.S., F.R.M.S. took the chair at 7-30, in the Zoology Theatre.

2. The Report of the Council on the Session 1896-97 (see "Proceedings," Vol. XI., p. viii.) was submitted and adopted.
3. The Treasurer's Balance Sheet for the Session 1896-97 (see "Proceedings," Vol. XI., p. xxxi.) was submitted and approved.
4. The Librarian's Report (see "Proceedings," Vol. XI., p. xxiv.) was submitted and approved.
5. The following Office-bearers and Council for the ensuing Session were elected: — Vice-Presidents, H. C. Beasley and Prof. Herdman, D.Sc., F.R.S.; Hon. Treasurer, T. C. Ryley; Hon. Librarian, Andrew Scott; Hon. Secretary, Joseph A. Clubb, M.Sc.; Council, H. O. Forbes, LL.D., F.Z.S., Prof.

Harvey Gibson, M.A., K. Grossman, M.D., W. J. Halls, Rev. de B. Klein, D.Sc., Rev. T. S. Lea, M.A., G. H. Morton, F.G.S., John Newton, M.R.C.S., C. Ricketts, M.D., W. E. Sharp, Prof. Sherrington, F.R.S., and A. O. Walker, F.L.S.

6. The President delivered the Inaugural Address, entitled "Advances in Biological Science during the Victorian Era" (see "Transactions," p. 1). A vote of thanks was proposed by Dr. de Beaumont Klein, seconded by Mr. H. C. Beasley, and carried with acclamation.

The second meeting of the twelfth session was held at University College on Friday, November 12th, 1897. The President in the chair.

1. A series of miscellaneous exhibits was on view in the Zoological Laboratory from 7 to 7-30.
2. Prof. Paterson gave an account of the successful maceration of an Indian elephant, by allowing it to lie for a period of three months under river sand. At the end of that time the bones were well cleared of flesh through the agency of fly larvæ and possibly bacteria. A discussion followed.
3. Prof. Herdman, F.R.S., delivered a lecture on "A Zoological Trip to America and the Pacific Coast, with an account of the Plankton collected continuously during two traverses of the North Atlantic" (see "Transactions," p. 33).

The third meeting of the twelfth session was held at University College on Friday, December 10th, 1897. The President in the chair.

1. Miscellaneous exhibits in the Zoological Laboratory from 7 to 7-30.

2. Prof. Herdman, F.R.S., submitted the Eleventh Annual Report on the work of the Liverpool Marine Biology Committee and the Port Erin Biological Station (see "Transactions," p. 91).

3. Mr. G. H. Morton, F.G.S., gave short papers on "The Elephant in Cheshire" (see "Transactions," p. 155), and on "Buried Bones about Liverpool" (see "Transactions," p. 147).

4. Mr. Alfred O. Walker, F.L.S., contributed a paper entitled "Contributions to the Malacostracan Fauna of the West of Ireland" (see "Transactions," p. 159).

5. Mr. Lionel J. Picton, B.A., submitted a paper on "The Corpuscles of certain Marine Worms" (see "Transactions," p. 136).

6. Rev. T. S. Lea, M.A., exhibited, with description, a series of lantern slides showing Sea-Anemones in their natural habitats in rock-pools at Port Erin.

7. Mr. Alfred O. Walker, F.L.S., gave a note on the occurrence in quantity of *Crepis taraxacifolia* at Colwyn Bay in 1896-97 (see "Transactions," p. 173).

The fourth meeting of the twelfth session was held at University College on Friday, January 14th, 1898. The President in the chair.

1. In the Zoological Laboratory, Prof. Herdman exhibited and described (*a*) The MacDonald Hatching Jar, used for hatching lobsters in the United States, and (*b*) models and photographs illustrating oyster and mussel culture in France and Holland.

2. Dr. de Beaumont Klein gave a lecture on "Lake Dwellings in Switzerland." A graphic account was given of these interesting structures, found in such numbers on the borders of the Swiss lakes, and many points of interest were mentioned. A number of lantern illustrations were shown. An interesting discussion followed, in which Dr. Newton, Prof. Herdman, Mr. Beasley, Mr. Picton, and others took part.

The fifth meeting of the twelfth session was held at University College on Friday, February 11th, 1898. The President in the chair.

1. Miscellaneous exhibits in the Zoological Laboratory from 7 to 7-30.

2. Mr. T. C. Ryley exhibited, with remarks, the case or nest of the New Zealand insect *Thyridopteryx ephemeræformis.*

3. Mr. F. J. Cole submitted a paper entitled "Reflections on the Cranial Nerves and Sense Organs of Fishes" (see "Transactions," p. 228).

4. The Annual Report on the work of the Sea-Fisheries Laboratory for 1897, by Prof. Herdman, F.R.S., Mr. Andrew Scott, and Mr. James Johnstone, was laid on the table (see "Transaction," p. 176).

The sixth meeting of the twelfth session was held at University College on Friday, March 11th, 1898. The President in the chair.

1. Miscellaneous exhibits in the Zoological Laboratory from 7 to 7-30.

2. Dr. W. H. Gaskell, F.R.S., Cambridge, delivered a lecture on "The Lamprey and its Transformation." The lecturer first of all sketched out in a most interesting manner the changes undergone by the larval Ammocœtes before its final metamorphoses into the adult Lamprey, and traced out a wonderful series of resemblances between structures found in *Limulus*—the King-Crab—and in certain stages of the development of the Lamprey. The lecture was listened to with great interest by a large audience, and the Society is to be congratulated in having the opportunity of hearing from Dr. Gaskell's lips an account of his work on the evolution of the Vertebrata. An animated discussion followed, in which Profs. Sherrington, Herdman, and Paterson, and Dr. Klein and Mr. Cole took part. A cordial vote of thanks was passed to Dr. Gaskell.

The seventh meeting of the twelfth session was held at University College on Friday, May 13th, 1898. The President in the chair.

1. Prof. Sherrington demonstrated a series of microscopical preparations of Sensorial End Organs, and Mr. I. C. Thompson exhibited specimens of the Alga *(Trichodesmium erythræum)*.

2. A note on "A Tetramerous Specimen of *Echinus esculentus*," by Mr. H. C. Chadwick, was communicated by the Hon. Secretary (see "Transactions," p. 288).

3. Mr. Alfred O. Walker, F.L.S., described a series of Crustacea from Puget Sound, British Columbia (see "Transactions," p. 268).

4. Mr. Joseph A. Clubb, M.Sc., contributed a paper on "The Mesenteries and Œsophageal Grooves of *Actinia equina*, Linn." (see "Transactions," p. 300).

5. Prof. Herdman, F.R.S., described a collection of Tunicata, from Puget Sound, British Columbia (see "Transactions," p. 248).

6. Mr. I. C. Thompson, F.L.S., gave a paper on "A Collection of Antarctic Plankton" (see "Transactions," p. 291).

The eighth meeting of the Society was the Annual Field Meeting, and was held on Saturday, July 2nd, at West Kirby and Hilbre Island. A very enjoyable afternoon was spent on the rocks at Hilbre at low water, after which the party adjourned to West Kirby and had tea. A short business meeting was afterwards held. Mr. I. C. Thompson, the Chairman, proposed the election of Prof. Sherrington, F.R.S., as President for next session. Mr. G. H. Morton seconded, and the motion was carried with acclamation. Prof. Herdman then moved a vote of thanks to Mr. I. C. Thompson, the retiring President, which was seconded by Mr. Clubb, and carried.

LAWS of the LIVERPOOL BIOLOGICAL SOCIETY.

I.—The name of the Society shall be the "LIVERPOOL BIOLOGICAL SOCIETY," and its object the advancement of Biological Science.

II.—The Ordinary Meetings of the Society shall be held at University College, at Seven o'clock, during the six Winter months, on the second Friday evening in every month, or at such other place or time as the Council may appoint.

III.—The business of the Society shall be conducted by a President, two Vice-Presidents, a Treasurer, a Secretary, a Librarian, and twelve other Members, who shall form a Council; four to constitute a quorum.

IV.—The President, Vice-Presidents, Treasurer, Secretary, Librarian, and Council shall be elected annually, by ballot, in the manner hereinafter mentioned.

V.—The President shall be elected by the Council (subject to the approval of the Society) at the last Meeting of the Session, and take office at the ensuing Annual Meeting.

VI.—The mode of election of the Vice-Presidents, Treasurer, Secretary, Librarian, and Council shall be in the form and manner following:—It shall be the duty of the retiring Council at their final meeting to suggest the names of Members to fill the offices of Vice-Presidents, Treasurer, Secretary, Librarian, and of four Members who were not

on the last Council to be on the Council for the ensuing session, and formally to submit to the Society, for election at the Annual Meeting, the names so suggested. The Secretary shall make out and send to each Member of the Society, with the circular convening the Annual Meeting, a printed list of the retiring Council, stating the date of the election of each Member, and the number of his attendances at the Council Meetings during the past session; and another containing the names of the Members suggested for election, by which lists, and no others, the votes shall be taken. It shall, however, be open to any Member to substitute any other names in place of those upon the lists, sufficient space being left for that purpose. Should any list when delivered to the President contain other than the proper number of names, that list and the votes thereby given shall be absolutely void. Every list must be handed in personally by the Member at the time of voting. Vacancies occurring otherwise than by regular annual retirement shall be filled by the Council.

VII.—Every Candidate for Membership shall be proposed by three or more Members, one of the proposers from personal knowledge. The nomination shall be read from the Chair at any Ordinary Meeting, and the Candidate therein recommended shall be balloted for at the succeeding Ordinary Meeting. Ten black balls shall exclude.

VIII.—When a person has been elected a Member, the Secretary shall inform him thereof, by letter, and shall at the same time forward him a copy of the Laws of the Society.

IX.—Every person so elected shall within one calendar month after the date of such election pay an Entrance Fee of Half a Guinea and an Annual Subscription of One

Guinea (except in the case of Student Members); but the Council shall have the power, in exceptional cases, of extending the period for such payment. No Entrance Fee shall be paid on re-election by any Member who has paid such fee.

X.—The Subscription (except in the case of Student Members) shall be One Guinea per annum, payable in advance, on the day of the Annual Meeting in October.

XI.—Members may compound for their Annual Subscription by a single payment of Ten Guineas.

XII.—There shall also be a class of Student Members, paying an Entrance Fee of Two Shillings and Sixpence, and a Subscription of Five Shillings per annum.

XIII.—All nominations of Student Members shall be passed by the Council previous to nomination at an Ordinary Meeting. When elected, Student Members shall be entitled to all the privileges of Ordinary Members, except that they shall not receive the publications of the Society nor vote at the Meetings, nor serve on the Council.

XIV.—Resignation of Membership shall be signified *in writing* to the Secretary, but the Member so resigning shall be liable for the payment of his Annual Subscription, and all arrears up to date of his resignation.

XV.—The Annual Meeting shall be held on the second Friday in October, or such other convenient day in the month as the Council may appoint, when a Report of the Council on the affairs of the Society, and a Balance Sheet duly signed by the Auditors previously appointed by the Council, shall be read.

XVI.—Any person (not resident within ten miles of Liverpool) eminent in Biological Science, or who may have rendered valuable services to the Society, shall be eligible

as an Honorary Member; but the number of such Members shall not exceed fifteen at any one time.

XVII.—Captains of vessels and others contributing objects of interest shall be admissible as Associates for a period of three years, subject to re-election at the end of that time.

XVIII.—Such Honorary Members and Associates shall be nominated by the Council, elected by a majority at an Ordinary Meeting, and have the privilege of attending and taking part in the Meetings of the Society, but not voting.

XIX.—Should there appear cause in the opinion of the Council for the expulsion from the Society of any Member, a Special General Meeting of the Society shall be called by the Council for that purpose; and if two-thirds of those voting agree that such Member be expelled, the Chairman shall declare this decision, and the name of such Member shall be erased from the books.

XX.—Every Member shall have the privilege of introducing one visitor at each Ordinary Meeting. The same person shall not be admissible more than twice during the same session.

XXI.—Notices of all Ordinary or Special Meetings shall be issued to each Member by the Secretary, at least three days before such Meeting.

XXII.—The President, Council, or any ten Members can convene a Special General Meeting, to be called within fourteen days, by giving notice in writing to the Secretary, and stating the object of the desired Meeting. The circular convening the Meeting must state the purpose thereof.

XXIII.—Votes in all elections shall be taken by ballot, and in other cases by show of hands, unless a ballot be first demanded.

XXIV.—No alteration shall be made in these Laws, except at an Annual Meeting, or a Special Meeting called for that purpose; and notice in writing of any proposed alteration shall be given to the Council, and read at the Ordinary Meeting, at least a month previous to the meeting at which such alteration is to be considered, and the proposed alteration shall also be printed in the circular convening such meeting; but the Council shall have the power of enacting such Bye-Laws as may be deemed necessary, which Bye-Laws shall have the full power of Laws until the ensuing Annual Meeting, or a Special Meeting convened for their consideration.

BYE-LAW.

Student Members of the Society may be admitted as Ordinary Members without re-election upon payment of the Ordinary Member's Subscription; and they shall be exempt from the Ordinary Member's entrance fee.

LIST of MEMBERS of the LIVERPOOL BIOLOGICAL SOCIETY.

SESSION 1897-98.

A. Ordinary Members.

(Life Members are marked with an asterick.)

ELECTED.

1886 Banks, Prof. W. Mitchell, M.D., F.R.C.S., 28, Rodney-street

1886 Barron, Prof. Alexander, M.B., M.R.C.S., 34, Rodney-street

1888 Beasley, Henry C., Vice-President, Prince Albert-road, Wavertree

1894 Boyce, Prof., University College, Liverpool

1889 Brown, Prof. J. Campbell, 8, Abercromby-square

1887 Caine, Nathaniel, Spital, Bromborough

1886 Caton, R., M.D., F.R.C.P., Lea Hall, Gateacre

1886 Clubb, J. A., M.Sc., Hon. Secretary, Free Public Museums, Liverpool

1891 Dismore, Miss, 65, Shewsbury-road, Oxton

1897 Dutton, Dr. J. Everett, 502, New Chester-road, Rock Ferry

1894 Forbes, H. O., LL.D., F.Z.S., Free Public Museums, Liverpool

1891 Garstang, W., M.A., Lincoln College, Oxford

1886 Glynn, Prof. T. R., M.D., F.R.C.P., 62, Rodney-street

1886 Gibson, Prof. R. J. Harvey, M.A., F.L.S., University College

1894 Grossmann, Karl, M.D., 70, Rodney-street

1886 Halls, W. J., 35, Lord-street

1896 Haydon, W. H., 24, Upper Parliament-street

1886 Herdman, Prof. W. A., D.Sc., F.R.S., VICE-PRESIDENT, University College
1893 Herdman, Mrs., B.Sc., Croxteth Lodge, Ullet-road, Liverpool
1891 Hicks, J. Sibley, M.D., 2, Erskine-street
1894 Hickson, Prof. S. J., F.R.S., Owens College, Manchester
1897 Holt, Alfred, Crofton, Aigburth
1898 Johnstone, James, HON. LIBRARIAN, Fisheries Laboratory, University College, Liverpool
1886 Jones, Charles W., Field House, Prince Alfred-road, Wavertree
1894 Jones, Charles Elpie, B.Sc., Prenton-road. W., Birkenhead
1895 Klein, Rev. L. de Beaumont, D.Sc., F.L.S., 6, Devonshire-road
1894 Lea, Rev. T. S., 3, Wellington Fields, Wavertree
1896 Laverock, W. S., M.A., B.Sc., Free Museums, Liverpool
1886 Lomas, J., Assoc. N.S.S., F.G.S., 16, Mellor-road, Birkenhead
1893 Macdonald, J. S., B.A., 21, Hatherley-st., L'pool
1888 Melly, W. R., Ph.D., 90, Chatham-street
1886 Morton, G. H., F.G.S., 209, Edge-lane, E.
1888 Newton, John, M.R.C.S., 44, Rodney-street
1894 Paterson, Prof., M.D., M.R.C.S., University College, Liverpool
1894 Paul, Prof. F. T., Rodney-street, Liverpool
1892 Phillips, E., L.D.S., M.R.C.S., 33, Rodney-street
1896 Picton, W. H., 2, College-road, Gt. Crosby
1886 *Poole, Sir James, J.P., Abercromby-square
1897 Quayle, Alfred, 7, Scarisbrick New-road, S'port
1890 Rathbone, Miss May, Backwood, Neston
1895 Ricketts, C., M.D., 11, Hamilton-square, B'head

1887 Robertson, Helenus R., Springhill, Church-road. Wavertree
1897 Robinson, H. C., Holmfield, Aigburth
1887 Ryley, Thomas C., HON. TREASURER, 10, Waverley-road
1892 Sephton, Rev. J., M.A., 90, Huskisson-street
1894 Scott, Andrew, Piel, Barrow-in-Furness
1895 Sherrington, Prof., M.D., F.R.S., University College, Liverpool
1891 Sharp, W. E., The Woodlands, Ledsham
1886 Smith, Andrew T., Jun., 5, Hargreaves-rd., Sefton Park
1895 Smith, J., Rose Villa, Lachford, Warrington
1898 Suffield, Miss, University College, Liverpool
1893 Tate, Francis, F.C.S., 9, Hackins Hey, Liverpool
1886 Thompson, Isaac C., F.L.S., F.R.M.S., PRESIDENT, 53, Croxteth-road
1889 Thornely, Miss L. R., Baycliff, Woolton Hill
1888 Toll, J. M., 49, Newsham-drive, Liverpool
1886 Walker, Alfred O., J.P., F.L.S., Colwyn Bay
1897 Warrington, Dr. W. B., 80, Rodney-street
1889 Williams, Miss Leonora, Hill Top, Bradfield, nr. Sheffield
1891 Wiglesworth, J., M.D., County Asylum, Rainhill
1896 Woods, Joseph A., L.D.S. Eng., 76, Mount-pleasant, Liverpool
1892 Weiss, Prof., Owens College, Manchester
1896 Willmer, Miss J. H., 20, Lorne-rd., Oxton, B'head
1892 Young, T. F., M.D., 12, Merton-road, Bootle

B. STUDENT MEMBERS.

Armstrong, Miss A., 26, Trinity-road, Bootle
Bennette, Horace W. P., Gothic Lodge, Park-road, S., Birkenhead

Carstairs, Miss, Lily-road, Fairfield
Christophers, S. R., M.B., 25, Brompton-avenue, Sefton Park
Crompton, Miss C. A., University College, Liverpool
Dickinson, T., 3, Clark-street, Prince's Park
Drinkwater, E. H., Rydal Mount, Marlboro'-road, Tuebrook
Elder, D., 49, Richmond Park, Liverpool
Gill, E. S. H., Shaftsbury House, Formby
Hannah, J. H. W., 55, Avondale-road, Sefton Park
Harrison, Oulton, Denehurst, Victoria Park, Wavertree
Henderson, W. S., B.Sc., Beech-hill, Fairfield
Linton, S. F., St. Paul's Vicarage, Clifton-road, Birkenhead
Lloyd, J. T., 43, Ullet-road, Sefton Park
Quinby, F. G., 11, Belvidere-road, Liverpool
Simpson, A. Hope, Annandale, Sefton Park
Woolfenden, H. F., 6, Grosvenor-road, Birkdale

C. Honorary Members.

H.S.H. Albert I., Prince of Monaco, 25, Faubourg St. Honore, Paris
Bornet, Dr. Edouard, Quai de la Tournelle 27, Paris
Claus, Prof. Carl, University, Vienna
Fritsch, Prof. Anton, Museum, Prague, Bohemia
Giard, Prof. Alfred, Sorbonne, Paris
Haeckel, Prof. Dr. E., University, Jena
Hanitsch, R., Ph.D., Raffles Museum, Singapore
Leicester, Alfred, Buckhurst Farm, nr. Edenbridge, Kent
Solms-Laubach, Prof. Dr., Botan. Instit., Strassburg

REPORT of the LIBRARIAN.

An exchange, including past volumes, has been arranged between the Society and the California Academy of Sciences. Exchange have also been arranged with the Geological Society of Liverpool, and the Société Royale des Sciences in Upsala.

A beginning is being made with the arrangement of the Library, and it is proposed to draw up a catalogue for publication in the next volume of the Society's "Transactions."

Since the completion of the last binding scheme a large number of volumes and parts have been accumulated, and it is becoming necessary to institute a new fund for binding the many valuable publications in the possesion of the Society.

The following list gives the titles of the works received during the last session, both by exchange, by donation, and by purchase.

1. Amsterdam, Koninklijke Akad. van Wettenschappen. Vol. II., part 2; Vol. V. (Proceedings), Nos. 4—10, Jaarboek, 1896.
2. Batavia, Koninklijke Natuur. Vereenig. in Ned. Indie. Vol. LVI. (N.S., Vol. V.), Boekwerken, 1896.
3. Bergen, An Account of the Crustacea of Norway, G. O. Sars. Vol. I., parts 3—8 (Bergen Museum).
4. Bergen, Bergens Museums Aarbog for 1897. 1898.
5. Berlin, Mathematische und Naturwissenschaftliche Mittheilungen aus den Sitzungsberichten der Königlich Preussischen Akademie der Wissenschaften. Heft 1—10, 1897.
6. Berlin, Natürliche Schöpfungs-Geschichte. Parts 1 and 2. E. Haekel. From the Author.
7. Bonn, Sitzungsberichte der Niederrheinischen Gesellschaft für Natur- und Heilkunde, 1897.

8. Bonn, Verhandlungen des Naturhistorischen Vereins, Vierundfünfzigster Jahrgang, 1897.
9. Bonn, Naturh. Verein. des Preussichen Rheinlande, &c., Verhandl. Vol. LIII., part 2; Sitzungsberichte, 1896, part 2.
10. Brussells, L'Academie Royale des Sciences, Bulletins. Vol. XXX., XXXI., XXXII., XXXIII.
11. Brussells, Annuarie de L'Academie Royale des Sciences, 1896—97.
12. Buenos Aires, Museo Nacional, Anales. Vol. IV., Ser. II., part 1; Vol. V., Ser. II., part 2; Memoria, 1894—1896.
13. Boston, Proceedings of the Boston Society of Natural History. Vol. XXVII., No. 14; Vol. XXVIII., Nos. 1, 2, 3, 4, 5.
14. Bologna, Rendiconto delle sessioni della R. Accademia delle Scienze dell' Istituto di Bologna. Nuova Serie, Vol. I. Fasicolo 1—4, 1896—97.
15. Bologna, Memorie della R. Accademia delle Scienze dell' Istituto di Bologna. Serie V. Tomo V., 1895—96. (1) Memorie della Sezione di Medicina e Chirurgia; (2) Memorie della Sezionie delle Scienze Naturali.
16. Cambridge, Mass., U.S.A., Bulletin of the Museum of Comparative Zoology at Harvard College. Vol. XXX., No. 6; Vol. XXXI., Nos. 1—5.
17. Cambridge, Mass., U.S.A., Annual Report of the Curator of the Museum of Comparative Zoology at Harvard College, 1896—97.
18. Charlottenburg, Zeitschrift für Fischerei und deren Hilfswissenschaften mit Einschluss von Fischwasser-Hygiene, Fischerei und Wasserrecht. Vol. IV., parts 3 and 4; Vol. V., parts 1 and 2.
19. Christiania, Videnskabs-Selskabet, Forhandlinger, 1896.
20. Chicago, Second and Third Annual Reports for the year 1897 of the John Crerar Library. 1898.
21. Dublin, The Scientific Proceedings of the Royal Dublin Society. Vol. VIII. (N.S.), part 5, July, 1897.
22. Dublin, The Scientific Transactions of the Royal Dublin Society. Vol. V. (Ser. II.), part 13; Vol. VI. (Ser. II.), parts 2 to 13.
23. Edinburgh, Fishery Board for Scotland, Fifteenth Annual Report, part 3.
24. Edinburgh, Proceedings of the Royal Physical Society, Session 1896 and 1897.
25. Edinburgh, Royal College of Physicians, Laboratory Reports. Vol. VI.
26. Frankfurt, Senckenbergische Naturforschende, Gesellschaft, 1896 and 1897.
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No. 1125—1130

No. 1131 (Vol. XX., pp. 487—499, with plates XXXVI--XXXIX.)—Notes on a Collection of Fishes from the Colorado Basin in Arizona. C. H. Gilbert and N. B. Scofield.

No. 1132 (Vol. XX., pp. 501—505)—Preliminary Diagnosis of New Mammals of the genera Sciurus, Castor, Neotoma, and Sigmodon, from the Mexican border of the United States. E. A. Mearns, M.D.

No. 1133 (Vol. XX., pp. 507—548, plates XI.—LIV.)—Notes on the Trematode Parasites of Fishes. E. Linton, Ph.D.

(Vol. XX., pp. 549—625) Contributions to Philippine Ornithology. Dean C. Worcester, A.B., and F. S. Bourns, M.D.

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(Vol. XX., pp. 643—694) Observations on the Astacidæ in the U.S. Natural Museum and in the Museum of Comparative Zoology, with descriptions of new species. W. Faxon.

(Vol. XX., pp. 695—708) A revision of Tropical African Diplopoda of the family Strongylosomatidæ. O. F. Cook.

Washington—

(Vol. XX., pp. 709—773) American leaf-hoppers of the sub-family Typhlocybinæ. C. P. Gillette.

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AMSTERDAM.—Koninklijke Akadamie van Wettenschappen.
Koninklijke Zoölogisch Genootschap Natura Artis Magistra.
BALTIMORE.—Johns Hopkins University.
BATAVIA.—Koninklijke Natuurkundig Vereeniging in Ned. Indie.
BERGEN.—Museum.
BERLIN.—Konigl. Akadémie der Wissenschaften.
Deutscher Fischerei-Vereins.
BIRMINGHAM.—Philosophical Society.
BOLONGA.—Accademia delle Scienze.
BONN.—Naturhistorischer verein des Preussichen Rheinlande und Westfalens.
BORDEAUX.—Société Linnéenne.
BOSTON.—Society of Natural History.
BRUSSELS.—Académie Royal des Sciences, etc., de Belgique.
CAMBRIDGE.—Morphological Laboratories.
CAMBRIDGE, MASS.—Museum of Comparative Zoology of Harvard College.
CHRISTIANIA.—Videnskabs-Selskabet.
DUBLIN.—Royal Dublin Society.
EDINBURGH.—Royal Society.
Royal Physical Society.
Royal College of Physicians.
Fishery Board for Scotland.
FRANKFURT.—Senckenbergische Naturforschende Gesellschaft.
FREIBURG.—Naturforschende Gesellschaft.
GENEVE.—Société de Physique et d'Histoire Naturelle.
GIESSEN.—Oberhessische Gesellschaft für Natur und Heilkunde.
GLASGOW.—Natural History Society.
GOTTINGEN.—Konigl. Gesellschaft der Wissenschaften.
HALIFAX.—Nova Scotian Institute of Natural Science.
HARLEM.—Musée Teyler.
Société Hollandaise des Sciences.
HELGOLAND.—Königliche Biologische Anstalt.
KIEL.—Naturwissenschaftlichen vereins fur Schleswig—Holstein.
Kommission fur der Unterschung der Deutschen meere.
KJOBENHAVN.—Naturhistorikc Forening.
Danish Biological Station (C. G. John Petersen).
Kongelige Danske Videnskabernes Selskab.
LEEDS.—Yorkshire Naturalists' Union.
LEIPZIG.—Konigl. Sachs. Gesellschaft der Wissenchaften.

LILLE.—Revue Biologique du Nord de la France.

*LIVERPOOL.—Geological Society,
*Bulletin of the Liverpool Museum.

LONDON.—Royal Microscopical Society.
British Museum (Natural History Department).

MANCHESTER.—Microscopical Society.
Owens College.

MARSEILLES.—Station Zoologique d'Endoume.
Musée d'Histoire Naturelle.

MASSACHUSETTS.—Tufts College Library.

MECKLENBURG.—Vereins der Freunde der Naturgeschichte.

MELBOURNE.—Royal Society of Victoria.

MONTPELLIER.—Académie des Sciences et Lettres.

MOSCOU.—Société Impériale des Naturalistes.

NANCY.—Société des Sciences.

NAPOLI.—Accademia delle Scienze Fisiche e Matematiche.

NEW BRUNSWICK.—Natural History Society.

OPORTO.—Annaes de Sciencias Naturaes.

PARIS.—Museum d'Histoire Naturelle.
Société Zoologique de France.
Bulletin Scientifique de la France et de la Belgique

PHILADELPHIA.—Academy of Natural Sciences.

PLYMOUTH.—Marine Biological Association.

ST. LOUIS, MISS.—Academy of Science.

ST. PETERSBURG.—Académie Impériale des Sciences.

SAN FRANCISCO.—California Academy of Science.

SANTIAGO.—Société Scientifiq du Chili.

STAVANGER.—Stavanger Museum.

STOCKHOLM.—Académie Royale des Sciences.

SYDNEY.—Australian Museum.

TOKIO.—Imperial University.

TORINO.—Musei de Zoologia ed Anatomia Comparata della R. Universita.

TORONTO.—Canadian Institute.

TRIESTE.—Societa Adriatica de Scienze Naturali.

UPSALA.—Upsala Universitiet.

*UPSALA.—Société Royale des Sciences.

WASHINGTON.—Smithsonian Institution.
United States National Museum.
United States Commision of Fish and Fisheries.

WELLINGTON, N.Z.—New Zealand Institute.

WIEN.—K. K. Naturhistorischen Hofmuseums.
K. K. Zoologisch—Botanischen Gesellschaft.

ZURICH.—Zurcher Naturforschende Gesellschaft.

Those marked with * are the additions.

THE LIVERPOOL BIOLOGICAL SOCIETY.

Dr. In Account with T. C. RYLEY, Hon. Treasurer. **Cr.**

1898.	£	s.	d.
To Use of Rooms, University College	3	3	0
,, Tea and Attendance at Meetings	3	10	0
,, Printing and Stationery—			
Dobb, T. & Co.	36	2	8
Vaughan, F., Ltd.	5	15	0
Dellegana & Co.	1	1	0
Brown, S.	7	17	6
,, Cost of Lantern Exhibitions	0	15	0
,, Postages and Carriage of Vols.	9	3	9
,, Sundries	0	4	9
,, Balance in hand, September 30th, 1898	68	3	5
	£135	16	1

1898.	£	s.	d.
By Balance, 30th September, 1897	79	18	7
,, 4 Members' Entrance Fees at 10/6	2	2	0
,, 5 Student Members' Entrance Fees at 2/6	0	12	6
,, 45 Members' Subscriptions at 21/-	47	5	0
,, 1 Do. Do., due 1898.	1	1	0
,, 10 Student Members' Subscriptions at 5/-	2	10	0
,, Sale of Proceedings	2	7	0
	£135	16	1
By Balance brought down	£68	3	5

T. C. RYLEY,
Hon. Treasurer.

Audited and found correct,
A. T. SMITH, Junr.

Liverpool, *October 5th*, 1898.

TRANSACTIONS

OF THE

LIVERPOOL BIOLOGICAL SOCIETY.

INAUGURAL ADDRESS

ON

ADVANCES IN BIOLOGICAL SCIENCE DURING THE VICTORIAN ERA.

BY

ISAAC C. THOMPSON, F.L.S., PRESIDENT.

(Plates I., II., III., IV.)

[Read October 15th, 1897.]

A DECADE has passed since the Liverpool Biological Society was ushered into existence, and under the untiring fostering care of its founder, it continues to hold a prominent position among the scientific bodies of our city. Most of those who took part in its inauguration are happily still amongst us, and we cherish in fond memory the names of Drysdale, Moore, Archer, and others no longer with us, who added lustre to the Society in its earlier days, and gave the charm of their presence and personality to our gatherings.

Through your kindness and goodwill your hitherto Chancellor of the Exchequer is this evening raised to the post of Prime Minister, enabling him to look upon his confréres in a calm, unprejudiced manner, without an eye to the coin of the realm, unfortunately a necessary factor to the well-being of any organised institution or society.

As a topic for a presidential address I had already commenced upon a subject of great interest, and affording

considerable scope in one department of biological research, when it forcibly occurred to me that in this year of our Queen's Jubilee no theme could be more appropriate, or possibly more popular, than a review of the advances in biological science during the past sixty years known as the Victorian Era. I therefore decided upon this very fruitful subject—a subject which the more it is looked into the vaster it becomes, and I cannot pretend, in an hour, to touch upon more than the most prominent of the many advances for which this age will be famous.

It would be a curious task to ascertain how many comparisons have been this year drawn in every branch of industry, science, literature, and art, between the present and the past, showing, at any rate, as regards industry and science, advances far vaster than could have been possible at any former similar period of time. In view of all the brilliant and unprecedented achievements in physical science which have occurred during the Queen's reign it would perhaps be rash to claim as great a development in biological science. But it is doubtless profoundly true to say that in no other department of knowledge has any theory or discovery advanced or made during the Victorian Era so affected the thoughts and beliefs of mankind in all sorts of ways, to such an extent as has the Darwinian doctrine of Evolution—the crowning biological truth of our time. And it would be equally safe to assert that very few names in any sphere of life will be more cherished and remembered as a part of the century itself than that of Charles Darwin [Plate I.] who, by his genius and perseverance, was able to bring about this revolution in the thoughts of his age. Let us take a glance back at the position of natural history in 1837. Cuvier [Plate II.], the greatest naturalist of his time, had died five years before, soon after the completion of the second edition,

in five volumes, of his great work, "Regne animal distribue d'apres son organization," a work embodying the results of all his previous researches on the structure of living and fossil animals, and first published in 1828.

In the matter of classification, Cuvier substituted a natural arrangement for the artificial one of Linnæus, grounding it upon the principle of anatomical structure. In palæontology, Cuvier made great advances upon the knowledge of his time, and to him the world owes the first systematic application of the science of comparative anatomy, whereby he reconstructed extinct animals from their fossil remains, and compared them with their living successors.

In comparing the present with the past, it is of interest to notice the very striking advances made since Cuvier's time in our knowledge of living animals, by far the greater number of known species having been recorded since then. The total number of species known sixty years ago was about 70,000, whereas the present total far exceeds one million; and, whereas a memoir on one group was formerly considered an exhaustive treatise, now many volumes are required to do justice to one branch of the group. Cuvier stands just half-way between Buffon and our own time. Buffon, too, had realised that similar causes to those operating at the present time had sculptured the past history of our earth, and that organisms were greatly influenced by food, climate, and other circumstances, and in this way he may be said to have, 100 years ago, helped to pave the way for the reception of the doctrine of descent. It is, at the same time, curious to notice that when Darwin wrote the "Origin of Species," he was not acquainted with Buffon's writings, and in 1865 he replied to Huxley in regard to them—"It would have annoyed me extremely to have republished Buffon's

views, which I did not know of, but I will get the book"; and later on he writes—"I have read Buffon; whole pages are laughably like mine. It is surprising how candid it makes one to see one's views in another man's words."

A bright star was shining at the time of the Queen's accession in the person of Edward Forbes [Plate II.] one of the most genial and loveable of men, and who, in his too short life, earned an undying name as a naturalist of the true type. Born in 1815 at Douglas, Isle of Man, and dying at Edinburgh in 1854, he crowded into 25 of those 39 years, as his biographers say, "more work than most men accomplish even when their span of days stretches beyond the allotted three score years and ten." As a disciple of Cuvier, Forbes was a believer in the fixity of species, looking upon the organic world as an embodiment of the thoughts of the Creator. Botany, zoology, geology, and palæontology were all favourite pursuits with him during his earlier years, while destined for the medical profession, which, however, he never adopted, happily deciding upon the career of a professor of natural history. In 1842 he accepted the Chair of Botany in King's College, London, and two years afterwards was appointed Palæontologist to the Geological Survey. During previous years he had enjoyed frequent opportunities of foreign travel, often returning to the Isle of Man, where, and around our coasts, marine zoology was his favourite pursuit, and was subsequently his absorbing delight. He was the first to recognize the value of the dredge in zoological research. In his "Natural History of the European Seas," he says, "Beneath the waves there are many dominions yet to be visited, and kingdoms to be discovered, and he who venturously brings up from the abyss enough of their inhabitants to display the physiognomy of the country,

will taste that cup of delight, the sweetness of whose draught those only who have made a discovery know." In studying the distribution of animal life in the sea, Forbes recognized several "zones of depth," each characterized by particular types of animals—as littoral zone, laminarian zone, coralline zone, and deep-sea coral zone. But on account of the gradual paucity of life as depth increased, Forbes placed the zero of animal life at about 300 fathoms, concluding that no life could exist at greater depths. It remained for the "Challenger" Expedition, many years afterwards, to show that ocean depths are not barren solitudes, but the abode of innumerable remarkable forms of life.

Forbes did more than any man of his day to diffuse abroad a love for natural history, one of his chief aims being to elucidate the past organic history of the earth from a knowledge of its present living forms. He loved to call himself a zoo-geologist. Among his many published writings, his "History of British Starfishes," "A Monograph of the British Naked-Eyed Medusæ," and with Hanley, the "Handbook of British Mollusca," are still standard works with naturalists. The goal of his ambition was reached (in 1854) when he received the appointment of Professor of Natural History in Edinburgh University, which, however, he lived but a few months to enjoy.

In 1842, Steenstrup, of Copenhagen, published a remarkable work "On the Alternation of Generations," showing that many species of animals are represented by two perfectly distinct types or broods, differing from each other in form, structure, and habits. The now well-known phenomenon may be particularly well observed among the Zoophytes and the Medusæ.

In 1844 a very remarkable book appeared, entitled the "Vestiges of the Natural History of Creation," the

authorship of which was for nearly forty years entirely unknown save to five people. In 1883, however, on the death of Wm. Chambers, of Edinburgh, his brother Robert was authoritatively announced by his friend, Mr. Alexander Ireland, the sole survivor of the five, as the author. The chief object of the book was to extend the conception of the province of law in the universe, and to establish the theory of development. It is conceived and written in a distinctly reverent and religious spirit. The writer held that every discovery of a new scientific truth was but a stepping-stone to something beyond, leading to a more accurate knowledge of the laws by which the Divine mind acts in the material and moral world. As a purely literary work the "Vestiges" sufficiently shows the extremely wide mind of its author, as well as his powers of observation. The interest attaching to the work is now, however, chiefly historical, many of the statements probably resting on insufficient evidence. It deservedly produced a great sensation at the time, and was the immediate forerunner of Darwin's theory of evolution, although Darwin himself appears to have been little influenced by the book, or, indeed, enamoured with it, for he writes to Hooker respecting it—"The writing and arrangement are certainly admirable, but the geology strikes me as bad, and the zoology far worse."

Two other John the Baptists of evolution must not be passed over without mention, as affecting the thought of the early part of this century, viz., Erasmus Darwin [Plate II.] and Lamarck. The former, grandfather to the greatest of modern naturalists, was a well-known Lichfield physician, devoting his spare hours to gardening and natural history pursuits. Of his several writings, "Zoonomia" (published in 1794) is best known—a work on the laws of organic life, written with a view to unravel the theory of diseases.

In one of the chapters, entitled "Generation," is a passage almost prophetic of the line of thought that was to be one of the distinguishing features of the latter half of the following century, as proclaimed by his illustrious grandson, who we may reasonably suppose had dwelt upon the remarkable utterance. It runs as follows:—

"From thus meditating on the great similarity of the structure of the warm-blooded animals, and, at the same time, of the great changes they undergo both before and after their nativity; and by considering in how minute a portion of time many of the changes of animals above described have been produced; would it be too bold to imagine that in the great length of time, since the earth began to exist, perhaps millions of ages before the commencement of the history of mankind, would it be too bold to imagine that all warm-blooded animals have arisen from one living filament, which the Great First Cause endued with animality, with the power of acquiring new parts, attended with new propensities, directed by irritations, sensations, volitions, and associations, and thus possessing the faculty of continuing to improve by its own inherent activity, and of delivering down those improvements by generation to its posterity, world without end?"

Lamarck was of a speculative nature apt to roam beyond the warrant of facts. Accounting for the first appearance of life through spontaneous generation by means of heat and electricity, he explained in four propositions the entire organisation of animals, viz.:—

1. Life tends by its inherent forces to increase the volume of each living body and of all its parts up to a limit determined by its own needs.

2. New wants in animals give rise to new movements which produce organs.

3. The development of these organs is in proportion to their employment.

4. All that has been acquired, begun, or changed in the structure of individuals during the course of their life is preserved in reproduction and transmitted to the new individuals which spring from those which have experienced the changes.

He held that use and disuse were the primary factors of changes of organisation; that altered wants led to altered habits, resulting in the formation of new organs or in the modification of those already existing. Thus, animals pursued by carnivora would tend to have slender legs, while the giraffe, by constantly reaching up to the foliage of trees, increased its length of neck.

Lamarck was the first to distinguish vertebrate from invertebrate animals, by the possession of a backbone. He also founded the invertebrate groups, Crustacea, Arachnida, and Annelida.

In spite, however, of the advanced views of these few shining lights, but little advance in the popular mind as to the modus operandi of creation was apparent at the time of the Queen's accession, it being the general belief that plants and animals suddenly came into existence just as we see them. Any reasons for their grace and beauty were quite unknown.

The year of the accession itself (1837) was rendered famous by the publication of Von Baer's great work on "The Development of Animals," wherein he proved the complete resemblance between the embryos of various animals, as man, fish, dog, serpent, &c., leading up to the conclusion that each animal in its progress from the embryo to maturity recapitulates the series of changes through which the ancestral form passed; in other words, as was later tersely expressed by the distinguished living

naturalist, Haeckel [Plate III.] (an Hon. Member of this Society) "Ontogeny recapitulates Phylogeny."

Two years later (in 1839) Schwann discovered that all plants and animals are built up of cells, the lowest forms being one-celled, and the higher having many cells, from which result tissues and organs. This led to the discovery, by Von Mohl, five years later (in 1844), that these cells result from the complex union into one substance of the simple elements, oxygen, nitrogen, hydrogen, and carbon, that substance being named by him "protoplasm."

Such was about the position of biological science when (in 1859) Darwin's "Origin of Species" appeared, a book which has worked more extraordinary transformation in thought than any other of our time. The publication was hastened, as the author himself tells us, by his having received (in June, 1858) a paper entitled "On the Tendencies of Varieties to depart indefinitely from the Original Type," written by his friend, Alfred Russell Wallace [Plate IV.], containing, as he says, "exactly the same theory." It is a curious fact that both Darwin and Wallace should have been led to embrace the theory through reading Malthus's "Essay on Population."

That two fellow-countrymen should have quite independently hit upon the same theory is of itself a very remarkable fact, and it would be difficult to find a case of more complete unselfishness than that of Wallace in altogether sinking his own name in his love of "Darwinism."

It was, as Romanes says, "In the highest degree dramatic that the great idea of natural selection should have occurred independently, and in precisely the same form, to two working naturalists; that these naturalists should have been countrymen; that they should have agreed to publish their theory on the same day; and last, but not

least, that, through the many years of strife and turmoil which followed, these two English naturalists consistently maintained towards each other such feelings of magnanimous recognition that it is hard to say whether we should most admire the intellectual or the moral qualities which, in relation to their common labours they have displayed."

The chief point of divergence of views between Darwin and Wallace is, the contention by Wallace that the higher characteristics of man are due to the special endowment of "a spiritual essence or nature capable of progressive development under favourable conditions." Darwin, on the other hand, maintaining that the higher qualities of man were evolved by natural selection in precisely the same manner as his bodily structure.

Darwin had returned from his memorable five years' voyage in the 'Beagle,' in 1836, soon after which he produced one of the most charming works on natural history ever written—"A Naturalist's Voyage Round the World," followed by its sister volume on "Geological Observations."

His valuable work on "The Structure and Distribution of Coral Reefs," appeared shortly prior to the "Geological Observations," and gave to the world, for the first time, a scientific solution of this beautiful phenomenon. Although it has, in the opinion of many biologists, been surpassed by the more recent theory of Dr. John Murray, it is more than probable that both theories will hold good as applied to different localities.

Darwin's observations during his memorable voyage also bore fruit in the production of his exhaustive treatise, "Monograph of the Cirripedia," published by the Ray Society in 1851 and 1854—a book of 1,000 pages and 40 plates. Any one of these works would have been sufficient to place Darwin in the front rank of naturalists, and,

though still the standard works of their class, they are, as his work, almost obscured by the later works by which he became for ever immortalized. The details of the voyage itself are full of interest, and the notes in his diary by sea and land show that his eyes were always open to observe and note any phenomena of nature, however seemingly trivial and of whatever class. Whether in the domain of botany, geology, or zoology, he was equally at home, and if unable to explain any point at the time of observation, it was carefully noted for further examination or experiment.

As an instance of Darwin's observation of what might easily escape the notice of less keen naturalists, he discovered no less than 63 microscopic organic forms in the extraordinary showers of fine dust occasionally witnessed at sea, and, among other things, he thus accounts for the wide diffusion of the sporules of cryptogamic plants.

Within a year of his return to England Darwin took his degree of Master of Arts; three years later he married, and in 1842 settled at Down, in Kent. Then commenced the work in that quiet happy English home which, as Mr. Romanes says, "continued up to the day of his death, and which has been more effectual than any other in making the nineteenth century illustrious." For twenty-two years little was heard of Mr. Darwin, and we may easily imagine regrets expressed that the accomplished naturalist of the 'Beagle' should have retired into private life. But, in 1859, appeared his great, if not his greatest, work on the "Origin of Species," the result of twenty years' patient study and reflection. In the introduction to the book he modestly says;—

"When on H.M.S. 'Beagle' as naturalist, I was much struck with certain facts in the distribution of the organic beings inhabiting South America, and in the geological

relations of the present to the past inhabitants of that continent. These facts, as will be seen in the later chapters of this volume, seemed to throw some light on the origin of species—that mystery of mysteries, as it has been called by one of our greatest philosophers."

"On my return home it occurred to me (in 1837) that something might perhaps be made out of this question by patiently accumulating and reflecting on all sorts of facts which could possibly have any bearing on it. After five years I allowed myself to speculate on the subject, and drew up some short notes; these I enlarged (in 1844) into a sketch of the conclusions which then seemed to me probable; from that period to the present day I have steadily pursued the same object. I hope I may be excused from entering on these personal details, as I give them to you to show that I have not been hasty in coming to a decision."

Darwin founded his theory of "Natural Selection" on four axioms:—

1. That no two plants or animals are identical in all respects.

2. That the offspring tend to inherit the peculiarities of their parents.

3. That of those who come into existence, few reach maturity.

4. That those on the whole best adapted to the circumstances in which they are placed are the most likely to leave descendants.

It is an easily observed fact that in every generation of every species, far more individuals are born than can possibly survive, so that there is a constant battle for life going on amongst all organic beings. In this struggle for existence, those individuals, which are best fitted, by any slight variation, which can be of use in the struggle,

will be victorious, and will, therefore, be *naturally selected;* or, in other words, "nature selects the best individual out of each generation for life." These, again, transmit their characteristics to their descendants, thus tending by the survival of the fittest to perpetuate those individuals best adapted to their surroundings. When it is of advantage to man to utilize this law of nature, changes in a species of plants or animals may be, and are, brought about very quickly, witness the extraordinary varieties of pigeons, all of which have probably descended from the rock pigeon; or the varieties of sheep, cattle, or dogs, perpetuated by selecting such as possess any highly developed characteristic that can be considered beautiful or advantageous to themselves or to man. If, then, man can produce, and has produced, great results by *artificial* selection, what may not *natural* selection effect?

"Man selects for his own good, Nature for that of the being whom she tends." "Can we wonder, then," says Darwin, "that Nature's productions should be far truer in character than man's productions, that they should be infinitely better adapted to the most complex conditions of life, and should plainly bear the stamp of far higher workmanship."

When we see leaf eating insects green, and bark feeders mottled grey, the alpine ptarmigan white in winter, the red grouse the colour of heather, we must believe that these tints are of service to these birds and insects in preserving them from danger. Hence, through the lapse of ages those insects or birds which by any peculiarity of form or colour are best adapted to escape from the ravages of other animals or the sport of man, would survive and be the means of perpetuating those very peculiarities which are of advantage to them in the struggle for existence.

This struggle for life requires to be well thought over to show its reality. It is an essential of life that food should be provided. Thus the birds that delight us with their song are dependent on a good supply of seeds or insects. Darwin tells us he once dug and cleared a small piece of land, marking all seedlings of weeds as they came up. He found that, out of 357, no less than 295 were destroyed, chiefly by insects and slugs. To eat and be eaten seems the ruling function of animal and vegetable life, if not the end of their being, and their construction is in conformity with this law. Plants consume decaying animal and vegetable matter, which would else nourish seeds of disease; herbivorous animals eat the plants, carnivorous animals prey upon the herbivorous. An individual possessing the best biting machinery is the one most likely to survive, and produce similar offspring; vermin, parasites, temperature and climate, epidemics, preying animals, and man all play their part in this struggle, frequently causing a whole species to become extinct. On the other hand, if the check upon insect life were too rapid or disproportioned, whole species of plants must become extinct, as they are absolutely dependent for their very existence upon the visits of insects to ensure fertilization.

Darwin takes an imaginary case of a wolf, an animal depending upon capturing its prey by craft, strength, or fleetness. Suppose, from any cause, that the fleetest prey — deer, for instance — had increased in numbers through any change in the country, or that other prey had decreased in numbers during the season when the wolf was hardest pressed for food. The result would surely be that the fleetest and slimmest wolves would have the best chance of surviving, and so be preserved, or naturally selected, just as are fleetest greyhounds under

the careful and methodical selection of man. Another example is taken from the vegetable kingdom. Certain plants secrete a sweet juice apparently for the purpose of eliminating injurious matter from the sap. This is effected by glands or nectaries, such as can be seen by the microscope on the backs of laurel leaves, and in the less accessible parts of flowers. These juices are eagerly sought by insects which, while gathering them, are dusted by the pollen, and transmit the latter from flower to flower. Two distinct individuals would thus get crossed, the act of crossing being known to give rise to the most vigorous seedlings, which would consequently have the best chance of surviving. Those with the largest nectaries, by secreting most nectar, would be the oftenest visited and crossed. Somewhat similar would be the effect upon the insects depending upon nectar for food. A bee or other insect with a slightly lengthened or curved proboscis would more easily obtain food than others, and thus the communities to which they belonged would flourish and give rise to swarms possessing the same peculiarities.

The subject of the fertilization of plants has had an entirely new interest imparted to it by Darwin's researches. It was until recently believed that self-fertilization between the stamens and pistils in the same flower was the rule rather than the exception, but from the beautiful and striking instance of the primrose, Darwin exemplified the truth that cross fertilization is not only beneficial but may even be essential to plant life.

In one common variety of the primrose the stigma of the pistil overtowers the stamens, rendering self-fertilization impossible; in the other equally common variety, the reverse order obtains. But, in the first instance, the stamens being the lowest, the tip of a bee's proboscis is dusted by the pollen as it searches for nectar, and the bee,

perhaps next lighting on a primrose of the other variety, where the stigma of the pistil is longest, it receives the pollen from the tip of the bee's proboscis. If, on the contrary, a bee visits first the variety with the long stamens and short pistil, its head will probably receive a coating of pollen dust, which will be next imparted to a flower with a long pistil and short stamens, and so on. The result of this, as of other varieties of cross-fertilization, is to bring about a tendency to variation and change, and, in conformity with Nature's laws, to favour the evolution of new forms of species by the modification of the old.

"Natural selection," says Darwin, "acts only by the preservation and accumulation of small inherited modifications, each profitable to the preserved being; and as modern geology has almost banished such views as the excavation of a great valley by a single diluvial wave, so will natural selection banish the belief of the continued creation of new organic beings, or of any great and sudden modification."

The very important part played by insects in the fertilization of plants is now known to be even far greater than was then supposed, and following on analogous lines, the present year has witnessed a most interesting series of investigations by Dr. Amadeo Berlese, an Italian naturalist, as to the manner in which some insects, flies and ants especially, aid in the multiplication and spread of alcoholic ferments. He has shown that insects, far more than atmospheric air, contribute to the dissemination of yeasts, and considers it probable that during the cold season some yeasts are chiefly preserved inside the bodies of insects.

The circumstances favourable for the production of new forms, through "natural selection," are treated of at

length in the "Origin of Species"; as the "Intercrossing of Individuals," "Extinction Caused by Natural Selection," "Divergence and Convergence of Character," "Laws of Variation," "Use and Disuse of Parts," and a host of other subjects.

In considering the distribution of forms of life over the globe, Darwin lays stress on two great facts, viz., that climatical and other physical conditions of a continent, to a very small extent, account for the structural character and form of its inhabitants, but that natural barriers of any kind, or obstacles to free migration, have a most important bearing on the productions of various regions.

Thus, though America presents almost every variety of climate and temperature, and a parallel condition extends throughout the Old World, the fauna of the two are widely different; and if small areas of the Old World are hotter than any in the New, these are not inhabited by a fauna different from that of the surrounding districts. The inhabitants of Australia, Africa, and South America, though under the same latitude, are extremely different.

Great Britain possesses the same quadrupeds as the rest of Europe, because they were doubtless once united, while Europe, Australia, and South America do not possess one mammal common to all, because, so far as we can tell, they were never united. And so *ad infinitum.* Islands separated by deep channels from the mainland for ages, possess a different fauna. Floras, we have seen, are more uniform, doubtless accounted for by the fact that seeds being extremely hardy, are carried about by winds, sea currents, icebergs, and often by birds and insects. Remarkable instances are reported by Darwin of plants spread by these agencies.

Nothing has tended more to exemplify the truth of the Darwinian theory of development than the advances in

the science of embryology. It has been well called the key to the laws of animal development, although, as a science, almost created within the last half century. Before then it was not known that animals, entirely unlike one another when mature, might have almost exactly similar beginnings. The metamorphoses of insects, though so well known, are even *more* gradual than supposed, and show us what wonderful changes of structure can be effected during development.

The life history of an individual animal in a remarkable manner constitutes a sort of condensed epitome of its descent, and in no case more so than that of man.

Rudimentary organs, so common among man and animals, are easily explainable upon the Darwinian theory, but upon no other. The young whale, and also the calf, have rudimentary teeth never destined to cut the gums, because useless to them, but not so to their progenitors. The snake has, in like manner, rudimentary legs, never to be of service to it. Hosts of other examples might be given.

Use or disuse, Darwin thinks are important factors in increasing or reducing organs when changed habits require or no longer require them, and in this way natural selection has an important influence, and is, as Darwin says, "probably the main, though not the exclusive, means of modification."

"If, then," he sums up, "animals and plants do vary, let it be ever so slightly and slowly, why should not variations or individual differences, which are in any way beneficial, be preserved and accumulated through natural selection, or the survival of the fittest?"

"If man can, by patience, select variations useful to him, why, under changing and complex conditions of life, should not variations, useful to Nature's living products,

often arise, and be preserved or selected? What limit can he put to the power, acting during long ages, and rigidly scrutinizing the whole constitution, structure, and habits of each creature, favouring the good and rejecting the bad? I can see no limit to this power, in slowly and beautifully adapting each form to the most complex relations of life. The theory of natural selection, even if we look no further than this, seems to be in the highest degree probable."

Darwin concludes the "Origin of Species" with the following words:—

"There is grandeur in this view of life, with its several powers, having been originally breathed by the Creator into a few forms or into one, and that whilst this planet has gone cycling on according to the fixed law of gravity, from so simple a beginning, endless forms most beautiful and most wonderful have been, and are being, evolved."

Amid a storm of criticism and abuse the "Origin of Species" came upon the world. Pulpit orators found Mr. Darwin and his work fit examples of warning to their misled flocks, and longtailed ranters warmed him up before admiring throngs. Meanwhile, Darwin worked away in his quiet home, caring nothing for assault and banter, but eagerly examining into all real criticism on his work. Truth, and truth alone, he lived for. He cared not where his researches might lead him, or whether indeed they would lead him anywhere, as long as he got at truth in the investigation of Nature's secrets. For this he lived, and now his sons were assisting him in his grand work. But truth has a slow course when faced by prejudice, especially among the multitude of people whose theological professions lead them to test truth by its conformity with their rendering of the Biblical record, instead of reversing this order, and the "Origin of Species" required time for its digestion. But at length,

by slow degrees, its teachings were found to be not so very dreadful after all, and it had almost passed the three stages of every great truth, viz. :—1st, that it is contrary to scripture; 2nd, that there is nothing new in it; and 3rd, that people always believe it, when a book bearing the alarming title of "The Descent of Man," issuing from Darwin's pen, appeared. This was more than even the second half of the nineteenth century was prepared for, and the book, like its predecessor, met with a storm of abuse. Weak and unwilling adherents to the theories enunciated in the "Origin of Species" felt that the thick end of the wedge was being played, and it was now time to retire from so dangerous a game.

It was hard enough to believe that the inferior animals might have ascended or descended from a sponge or an amoeba, but that man himself should be the result of a little further development from the same humble stock was certainly more than they were inclined to accept. But those who were fortunate enough not to be bound by reputation, or to possess that confidence so easily acquired by a sublime ignorance of facts, on coming to calmly examine the facts and arguments contained in "The Descent of Man," found it to be but a necessary supplement to the "Origin of Species," man himself being formed in precise conformity to the same laws which govern the structure of the elephant or the lily. Charles Kingsley well said—"We believe that God is so wise that he made all things, why not believe that he is still wiser, and made all things make themselves."

Darwin commences this work by showing how notoriously it is a fact that man is constructed on the same general type or model as other animals. All the bones in his skeleton can be compared with corresponding bones in the monkey, bat, or seal. So it is with his muscles,

nerves, blood vessels, and internal viscera. The brain follows the same law, and embryological resemblances are still more remarkable. Rudimentary organs in man can be accounted for on no other hypothesis than that they were of use to a progenitor, and are only intelligible on the supposition that man is co-descendant with other mammals of some unknown lower form.

After quoting Huxley, who has been aptly called by Clodd the Apostle Paul of the Darwinian movement, to the effect that in every visible character, "man differs less from the higher apes than these do from the lower members of the same order of primates." Darwin devotes the third chapter to showing that "there is no fundamental difference between man and the higher mammals in their mental faculties."

"The difference is not slight," he says, "in moral disposition between a barbarian, such as the man described by the old navigator Byron, who dashed his child on the rocks for dropping a basket of sea urchins, and a Howard or a Clarkson; and in intellect between a savage, who uses hardly any abstract terms, and a Newton or Shakespeare. Differences of this kind between the highest men of the highest races and the lowest savages are connected by the finest gradations. Therefore, it is possible that they might pass and be developed into each other."

Man, having by whatever means become endowed with high mental faculties, he is, through their exercise, enabled to keep with an "unchanged body in harmony with the changing universe." To again quote Darwin—"He has great power of adapting his habits to new conditions of life. He invents weapons and tools, and employs various stratagems to procure food and to defend himself. When he migrates into a colder climate he uses clothes, builds

sheds, and makes fires, and by the aid of fires, cooks food otherwise indigestible. He aids his fellow-men in many ways, and anticipates future wants. Even at a remote period he practised some division of labour."

"The lower animals, on the other hand, must have their bodily structures modified in order to survive under greatly changed conditions. They must be rendered stronger, or acquire more effective teeth and claws for defence against new enemies; or they must be reduced in size so as to escape detection and danger. When they migrate into a colder climate, they must become clothed with thicker fur, or have their constitutions altered. If they fail to be thus modified, they will cease to exist."

On April 19th, 1882, the great spirit of Darwin passed away almost unobserved, so quick and accompanied by so little previous warning was his end, at the age of 71.

Though contrary to his understood wish that his body might be laid in the churchyard of his own village of Down, his family acquiesced in the universal expression of public feeling that Westminster Abbey should be the honoured resting place of his remains.

There, on April 26th, surrounded by a vast assemblage, including many of the foremost scientists of our day, the mortal remains of Charles Robert Darwin were committed to the tomb, and there it was my sacred privilege to lay a wreath upon his coffin on behalf of the scientific societies of our City of Liverpool. And as the impressive music of the anthem, "Happy is the man who findeth Wisdom and getteth Understanding," resounded through the venerable Abbey, it was solemnly felt that, though one of the wisest men of understanding that this world has ever known was no longer with us, we were left immeasurably the richer for his life and teaching.

Not only was Darwin the philosopher who has wrought

a greater revolution in human thought within a quarter of a century than any other man of our time—or perhaps, of any time—and has given what is proving the death blow to theological systems which had been clinging yet more tenaciously about men's shoulders, because of the effort to shake them off; but, as a man, he exemplified in his own life that true religion which is deeper, wider, and loftier than any theology.

Although Darwin's views were generally at first received with fierce hostility, he had very strong supporters, among the most distinguished of whom were Hooker, Huxley, and Herbert Spencer, all shining lights of the Victorian Era. Hooker's adherence is well seen in the very interesting "Life and Letters of Charles Darwin," by his son, Francis Darwin, now himself one of our most distinguished living botanists. Huxley's [Plate III.] "Man's Place in Nature" and "Coming of Age of the Origin of Species," and his many other lucid essays and writings, form a lasting monument of research, and are of themselves almost a liberal biological education.

Herbert Spencer [Plate III.] has been properly called a Darwinian before Darwin, and from an article which he wrote in the *Leader* newspaper in 1852, on the "Development Hypothesis," and recently quoted by Clodd in his excellent little book, "Pioneers of Evolution," as well as from several other articles published up to 1858, before his "Synthetic Philosophy" appeared, it is clear that Spencer had formulated his theory of evolution, as a whole, before Darwin propounded his great work dealing with *organic evolution* only.

A most important question in close relation with the Darwinian theory, and one likely to occupy the attention of biologists for some time to come, is that advanced by Professor Weismann [Plate IV.] of the non-inheritance

of acquired characters. It can only be alluded to here as one of the absorbing problems of our time, and was well handled by Professor Herdman in his presidential address before this Society in 1888. Its truth or partial truth will probably still remain a question of evidence. In spite, however, of much pains taken in the matter by many naturalists, I am not aware that any case has been satisfactorily proved in which a character acquired during the life of an organism has been transmitted to its descendants, while there is an enormous array of evidence tending to the belief that inborn, germinal, or constitutional variations alone are transmitable.

Meanwhile, many theories of heredity have been in the air, the most notable of them being those formulated by Herbert Spencer, Darwin, Francis Galton, and W. K. Brooks, to whose writings on the subject I need only to refer those interested in the subject.

In spite of Redi's conclusive experiments made as far back as 1668, spontaneous generation, or the belief that under certain conditions the non-living could be converted into the living, continued to be widely held during the earlier part of the Victorian Era. It was a well-known axiom of ancient science that the corruption of one thing is the birth of another, from the general belief that a seed dies before the young plant springs from it. Paul expressed a belief that was universally held 1800 years ago, when he said, "Thou fool, that which thou sowest is not quickened except it die," this belief remaining accepted down to the seventeenth century.

Schwann in 1837, Helmholz in 1843, and Schröder in 1859 showed, experimentally, that air after passing through red hot tubes, or through a close membrane of cotton wool, was deprived of something which caused fermentation or putrescence before being so treated; and Tyndall later

proved conclusively that ordinary air is thick with germs which can be filtered out, the air being rendered optically pure. But it was the great Pasteur [Plate III.] who went a step further, and showed that germs really do exist in the air capable of giving rise to the development of living forms in suitable menstrua.

1. Pasteur examined microscopically the cotton wool which had served as strainer, and clearly saw germs.

2. Having found them, he proved them able to give rise to definite living forms.

3. He showed that no change was effected in the constituents of the air by the wool, by dispensing with the latter altogether, and substituting a finely drawn-out tube bent downwards, attached to a bottle containing putrescible fluid. The fluid being carefully boiled, and the tube sufficiently heated to destroy any germs which might enter as the fluid cools, he demonstrated that it could be set aside for any time and no life will appear.

On the other hand, however, Dr. H. Charlton Bastian believed that he was not only able to form protoplasm by the combination of several organic substances, but that, under his watchful care, lowly forms of infusorial life had been generated from inorganic materials.

Huxley grasped the opportunity, and made Biogenesis *v.* Abiogenesis the subject of his address before the meeting of the British Association at Liverpool, in the year 1870, and I well remember listening to his eloquent voice on that occasion, and the subsequent discussion on the subject, which took place in section D. It proved the final death blow to spontaneous generation, and I am not aware that anyone has since attempted to resuscitate it.

But probably no error ever paved the way to more important or far reaching truths than did the error of spontaneous generation, for it led to the discovery of the

very important part played, both for good and evil, by those unseen organisms of extraordinary power, bacteria. One of the most important biological discoveries of our age was that made by Schwann in the year of Her Majesty's accession, that fermentation was due to the activity of yeast cells, and from it, though a quarter of a century later, Pasteur proved that certain diseases were due to the action of ferments in the living being. Meanwhile, it had often been observed that mortality in hospitals from compound fractures was very great, while single fractures were easily cured, and this led to Lister's notable discovery (in 1865) of the antiseptic treatment, by which wounds were protected from the entry of microbes, which are well-known to exist in our atmosphere in prodigious numbers, and to increase with extraordinary rapidity. The application of Lister's theory to surgery enabled surgeons to safely perform operations never before dreamt of, and also acted as a powerful stimulus to the investigation of the nature of the micro-organisms concerned with disease. The result has been the discovery that many diseases have each their special microbe—a discovery necessarily of the greatest value in diagnosis. But this branch of this evening's subject is so vast, and was so eloquently though too modestly handled by Lord Lister [Plate IV.] himself, in his memorable address as President of the British Association, at last year's meeting in our own city, that I need only refer to the address for a complete resumè of the subject.

It is remarkable how small facts, and even fictions often lead up to great results, and in this case they follow one another as surely as the rhymes in "The House that Jack Built." We have seen how spontaneous generation led to the discovery of fermentation, and this to the antiseptic treatment. This, again, led up to the germ

theory of diseases, and to increased knowledge of the bacilli, which required better microscopical lenses for their examination and identification than then existed. This led to the manufacture of apochromatic lenses, of new construction and power, which, added to other improvements in the microscope, based on the principle established by Lord Lister's father in the manufacture of achromatic glasses in the earlier part of the century (1829), seem to have apparently reached almost the highest perfection possibly required for microscopical manipulation.

The microscope has indeed in our time "grown from the comparatively rarely used possession of a few men of science to be the highly finished and most important companion of all investigators of Nature."

The actual value of minute organisms as agents in the very important matter of sewage purification, although seemingly very much like setting a thief to catch a thief, has, during recent years, been clearly demonstrated. Indeed, it was not until the biologist came to the aid of the chemist and engineer that a scientific method of purification of sewage was brought about. By turning the sewage into the sea, where circumstances render this favourable, a vast increase in the number of Entomostraca ensues, thus causing a corresponding increase of edible fish, and so benefitting man. But it has been more recently demonstrated, by the State Board of Health in Massachussets, that micro-organisms are themselves of the greatest value in the purification of sewage. After mechanical filtration of a volume through sand or gravel has taken place, sufficient air to support micro-organisms is admitted, which enters the pores of the filter, and with the help of the oxygen present, completely purifies organically impure sewage.

Indeed, the important part played by bacteria in many

relations, quite independent of disease, is daily becoming more apparent, so much so, that we may come to regard them more in the light of friends than as enemies. In many important processes of manufacture, results for long erroneously ascribed to chemical action, are now known to be biological, and due to micro-organisms. Even in our food products they sometimes actually prove a luxury. Where would our German cousins be without their Sauer Kraut, or our epicures without their game or Gorgonzola? We are probably still only on the verge of discovery of the preventive, if not the curative, value of micro-organisms, and it is one of the greatest features of biological science in the latter part of the Victorian Era, that our universities and colleges should possess chairs of bacteriology, with biological laboratories as well equipped as those of the chemists or engineers.

The systematic study of the life of the sea, so brilliantly initiated as we have seen by Edward Forbes, has only become a science during the last half of the Victorian Era, but has been during that period admirably carried out, not only by our own country, but by the United States, Norway, Italy, Austria, and France.

The lesser voyages of the "Lightning" (1868) and the "Porcupine" (1870), paved the way for the memorable voyage of the "Challenger," which, commanded by Captain Sir George Nares, and under the leadership of Sir Wyville Thomson, traversed, during 3½ years, upwards of 68,000 miles, and collected marine life at over 300 stations. The collections were carefully preserved by the naturalists on board, and on arrival home, were distributed amongst a large number of competent naturalists, and, under Dr. John Murray's able editorship, are now before the world in about 50 large profusely illustrated volumes, forming the finest library extant of works on

marine biology. The almost invisible and innumerable forms of life universally distributed throughout the ocean, taken with the finest tow-nets, as well as material dredged from the ocean floor, and the occupants of previously unknown regions, at a depth of from three to five miles, where their own phosphoresence furnished the sole wierd light, and plants and animals of many other kinds, were taken home to British and foreign laboratories.

Excellent work done by the United States is well reported on in the volumes entitled "Three Cruises of the SS. 'Blake,' in the Gulf of Mexico, in the Caribean Sea, and along the Atlantic Coast of the United States, from 1877 to 1880," by Alexander Agassiz.

The many biological stations scattered about the coasts of Europe and America are supplementing the valuable work of the cruising expeditions, and afford the most admirable means of studying the life history of hitherto little known animals. Of these, the earliest equipped, which has recently celebrated its twenty-fifth anniversary, is the fine station at Naples, where, under the directorship of Dr. Anton Dohrn, splendid biological work is being done, and memoirs of the highest character executed.

In our country four may be specially mentioned; the Plymouth Biological Station, under the directorship of Prof. Ray Lankester; the Gatty Marine Laboratory of St. Andrews, under Prof. M'Intosh; that of Millport, in the Island of Cumbrae, founded by that indefatigable naturalist, the late Dr. David Robertson; and the one which more immediately interests us, that of Port Erin, with Professor Herdman as director. All of these and many others, as well as several fresh-water biological stations, are annually proving their usefulness to students of biology, by enabling them to study living animals under natural conditions, for, as Professor Miall well said in the

opening sentence of his recent presidential address at Toronto—"It has long been my conviction that we study animals too much as dead things."

Akin to biological stations, and naturally associated with them, are fish hatcheries for the protection and artificial propagation of young food fishes, several of which are now established in our own and other countries, and are proving of the greatest value. The Fifteenth Annual Report of the Scottish Fishery Board, recently issued, states that at the Dunbar Hatchery, no less a number than 92,920,000 of various species of flat fish, chiefly plaice, turbot, and lemon sole, and some round fish, as cod and haddock, have been hatched and placed in the fishing grounds since the work was begun in 1894.

Not less important work is now being done by the Lancashire Fisheries Committee, whose fish laboratory has for some years been established in this College, under the directorship of Professor Herdman, assisted by Mr. A. Scott. The recent establishment of a hatching station on Peil Island, near Barrow, is expected to materially augment the important labours of the Committee.

Anthropology, now a most important branch of biological science, may be said to have only become a science during the Victorian Era. Mr. E. W. Brabrook, F.S.A., President of the Anthropological Institute, gives us, in his presidential address for the present year, some interesting particulars regarding it. The Ethnological Society of London was founded in 1843, an Ethnological Sub-section of Section D having been formed at the meeting of the British Association in 1846. The Anthropological Society of London was not formed until 1863, and in 1866 the British Association, for that year only, formed an Anthropological Sub-section of Section D, with Alfred Russell

Wallace as its President. In 1888 a department of Anthropology was, by the British Association, attached to the Biological Section; and, at Montreal in 1884, Anthropology became Section H, and has proved to be one of the most popular and interesting of the ten sections into which science, as dealt with by the British Association, is now divided.

In this connection, it is of interest to note that Section D (Biology) had previously comprised animal and vegetable Physiology and Anatomy, Ethnology and Anthropology, Zoology and Botany, these subjects having now four sections.

An important advance in biological science was achieved in the year 1870, by the recognition of the kinship of the Ascidians to the Vertebrata, through the very important discovery of the possession of a Notochord, by certain species of Ascidians while in the larval state, thus, to some extent, bridging over the wide gulf which had previously existed between vertebrata and invertebrata.

Although I have necessarily refrained from alluding to the many distinguished living biologists, I could not conclude an address of this nature, and especially in this theatre, without including amongst the conspicuous biological landmarks of our age, the distinguished occupant of the Chair of Natural History in this College. Professor Herdman's [Plate IV.] researches connected with the Tunicata, alone long ago placed him, as we all know, in the very front rank of living naturalists. As the founder and constant supporter of this Society, as well as of its sister institution, the Liverpool Marine Biology Committee, but still more for his own sake, we here delight to do him honour. Not a few of us have felt the extreme practical value of his always ready advice and assistance in any investigations we may undertake. And we can here

make not only the fittest return to him, but also the safest investment of time for ourselves, by individually endeavouring to co-operate and advance some branch of biological research. Great is the value of association, and it is perfectly true that feeble as anyone may be when standing alone, he can be strong when acting in union with other men, as in a Society like this. And surely the problems of biology should have an interest for everyone, including as they do the natural history of our own, and every other high or low class of organized beings, plants, or animals.

What secrets of Nature the next sixty years may unfold we cannot even guess at. The origin of life on our earth will probably still remain an unsolved mystery.

As biologists, it behoves us with unfettered minds and the faithful use of our highest powers of observation, to endeavour to unravel, for their own sake, the deep things of Nature, the love of truth being our guiding star.

On the PLANKTON COLLECTED CONTINUOUSLY DURING TWO TRAVERSES of the NORTH ATLANTIC in the SUMMER of 1897; with DESCRIPTIONS of NEW SPECIES of COPEPODA; and an APPENDIX on DREDGING in PUGET SOUND.

By W. A. HERDMAN, F.R.S.; I. C. THOMPSON, F.L.S.; and ANDREW SCOTT.

[With four cuts and plates V.—VIII.]

[Read November 12th, 1897.]

CONTENTS:

INTRODUCTION.

BY W. A. HERDMAN.

THE plan of this paper is briefly as follows:—During a trip to America between August 5th and October 5th, 1897, I collected surface plankton in both traverses of the Atlantic, and while at Puget Sound, on the Pacific Coast, dredged and collected at low tide. I noted everything seen in the living condition, and brought home a considerable collection of preserved specimens. My friends Mr. Isaac Thompson and Mr. Andrew Scott have kindly helped me to work out this collection, and the present joint paper is the result.

Through the kindness of R. G. Allan, Esq. (one of the owners), and of Captain Barrett, of the S.S. "Parisian,"

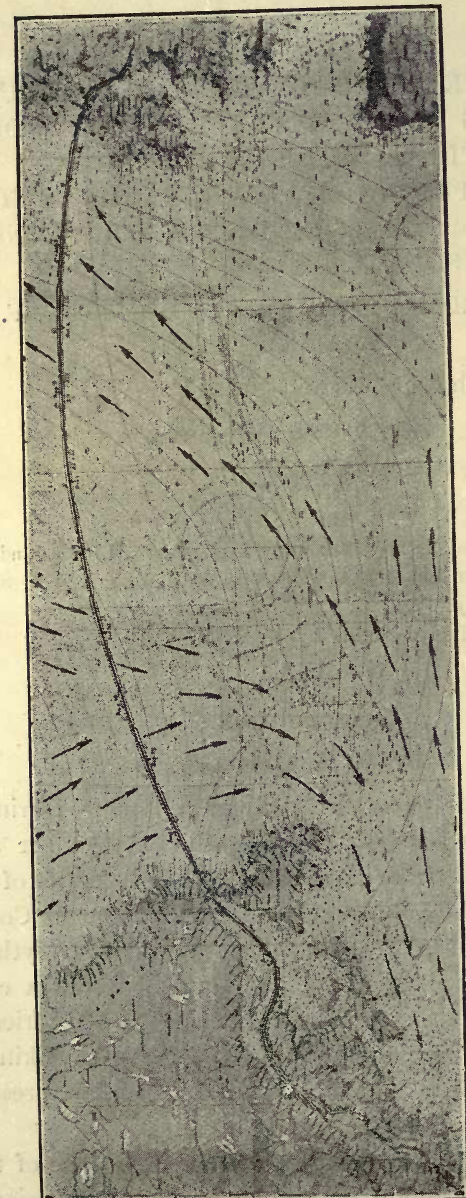


FIG. 1.—Plan of the course, showing the locality of each gathering, photographed from the chart. The position of the ship each day at noon is indicated by the date, *e.g.*, Aug. 9, near the centre. The brackets above the dark line show the gatherings taken on the voyage out, those below represent the return voyage. The arrows on the sea give an indication of the drift of the surface water.

belonging to the Allan Line, I was permitted to make arrangements for running sea-water through my silk tow-nets continuously, day and night, during the voyage from Liverpool to Quebec early in August, and back from Quebec to Liverpool at the end of September (fig. 1).

The method adopted was the "pump" one, by which the nets are not immersed in the sea, but are merely used to strain the organisms from the sea-water which has been pumped into the ship. My nets were made of the best silk bolting-cloth, known technically as grit-gauze, and I used the following four kinds:—

Net A, 32 meshes to the inch.
Net B, 72 meshes to the inch.
Net C, 80 meshes to the inch.
Net D, 172 meshes to the inch.

On the port side of the ship I was allowed to have complete command of a large tap on the main deck, near the galley. This brought sea-water from a large tank in

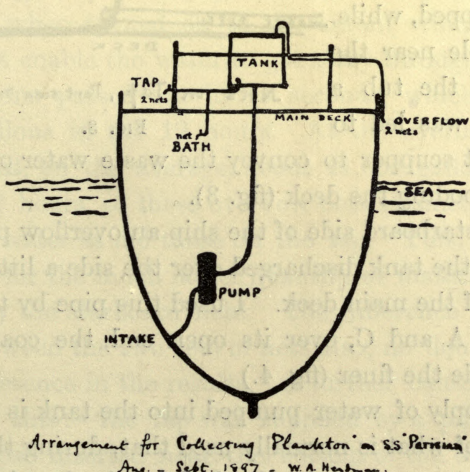
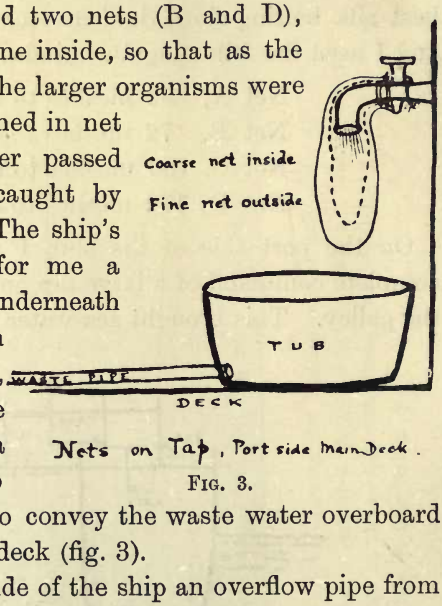


FIG. 2.—Rough diagram to show positions of tap, overflow pipe, &c.

the centre of the ship, which was kept constantly full for supplying baths, lavatories, &c., and for flushing purposes. The tap I used was an emergency one, rarely required. The tank is filled by a pump worked by the engines, so that it is in constant action while the ship is steaming. The sea-water enters by an aperture, provided with a valve, and covered by a grid of three-quarter inch mesh, placed in the ship's bottom, about 8 ft. above the keel and 14 ft. below the surface of the sea (fig. 2).

Over the tap I tied two nets (B and D), the coarser meshed one inside, so that as the water ran through, the larger organisms were screened off and retained in net B, while the smaller passed through and were caught by D, the outer net. The ship's carpenter fixed up for me a shallow tub placed underneath the tap, and into which my nets dipped, while, from a hole near the bottom of the tub a hose pipe was led to the nearest scupper to convey the waste water overboard without flooding the deck (fig. 3).



Nets on Tap, Port side Main Deck.

FIG. 3.

On the starboard side of the ship an overflow pipe from the top of the tank discharged over the side a little below the level of the main deck. I used this pipe by tying the two nets, A and C, over its open end, the coarser one being inside the finer (fig. 4.)

The supply of water pumped into the tank is so much in excess of what is normally used that, during the whole voyage, water was pouring freely from the four-inch overflow pipe. When the ship is rolling, however, the dis-

charge becomes somewhat intermittent—sudden rushes caused by the surging of the water in the tank alternating with a more steady flow. These great rushes of water led to the damage of some of the specimens collected in the coarser net on the overflow pipe — this was especially the case with the Amphipoda, Schizopoda, and larger Copepoda. As similar specimens were not so much damaged in the nets at the tap on the port side, we may conclude that little or no damage is received in passing through the pump.

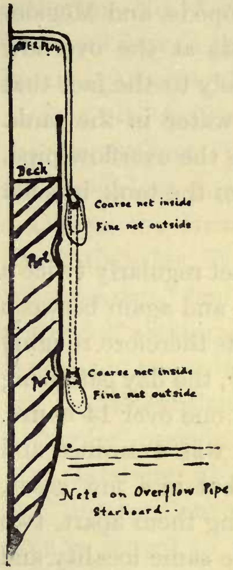


FIG. 4.

With the help of the carpenter I made an estimate of the amount of water passing through each of my nets during the period of time for which they were set. At the tap, when turned on to the extent which I found could just enable the water to get away through the nets, four gallons passed out in 45 seconds, which is about 3,600 gallons in the 12 hours. At the overflow pipe I found that, on the average, about 21,600 gallons passed in the 12 hours, so these overflow nets strained six times as much water as did those on the tap. This, of course, accounts for the much larger quantity of material usually caught by the starboard nets. The difference in size of mesh between the two sets of nets also, no doubt, caused some difference in the results. A further cause of difference was this:—the tap was supplied by a pipe coming from a rose inserted near the bottom of the tank, while the overflow pipe left the very top of the tank, and so carried off the surface water. I noticed frequently that

the larger animals and the more powerful swimmers, such as small fish, Amphipods, Schizopods, and Megalopas were nearly all caught in the nets at the overflow pipe, and I believe that was due merely to the fact that they swam nearer to the top of the water in the tank. This is an important reason for using the overflow pipe, as well as the ordinary taps leading from the tank, in such pump plankton work.

The four nets were emptied and re-set regularly twice a day, at sometime between 8 and 9 a.m., and again between 6 and 7 p.m. Each gathering represents therefore roughly about 12 hours fishing, or more exactly, the day gathering extended over 10 hours, and the night one over 14 hours. The contents of each of the four nets was examined and entered in the note-book separately, but in a few cases, when there seemed no object in keeping them apart, two or more of the gatherings taken in the same locality and period of time, were preserved in the same bottle. Each day and each night, then, of the voyage is represented in the collection by one or more—sometimes four or five—separate bottlefuls of plankton.

I may state at once that I saw no marked difference between the day and the night gatherings. It must be remembered, in this connection, that the source of the water was not quite close to the surface, but at least 14 ft. down.

The "Parisian" left Liverpool about 5-30 p.m. on August 5th, and I fixed my nets so that the water started running through them at 9 p.m. They were examined and emptied at 8 a.m. next morning. This was gathering No. 1. Gathering No. 2 was taken in the same way, from 11 a.m. to 3 p.m. on August 6th, as we lay in the mouth of Lough Foyle, near Moville. The nets were

re-set as we started off from Ireland at 4 p.m., and gathering No. 3 represents from that hour till 7 p.m. We were now in the open Atlantic, and the regular work began—gathering No. 4 being the night, from 8 p.m. on August 6th, to 9 a.m. on August 7th; gathering No. 5, the day August 7th, from 9 a.m. to 7 p.m., and so on (see list below, p. 42).

During the British Association Meeting at Toronto, I found that Mr. W. Garstang, on his voyage out in the "Laurentian," had made use of a somewhat less complete method of obtaining what may be considered as occasional samples of the surface life, by tying a small net over the tap in the gentlemen's bath, and turning the tap on at particular periods of the day for a couple of hours. Mr. Garstang, at Toronto, considered that this "bath tap" intermittent method might give additional information in regard to the distribution of organisms, and in showing the first and last appearance of any form. No doubt this ought to be the case to some extent, if a gathering happened to be taken just as the fauna was changing, but if this critical point be missed, then the method fails, and, in any case, the loss sustained by not having the collection a continuous one more than outweighs any possible advantage in getting earlier information as to the presence, in the water, of some special organism.

However, in order to test the intermittent method and compare it with the continuous gatherings, on the return journey, at the end of September, I attached a fifth fine silk net (same mesh as net D above) to the bath room tap (along with an explanatory notice), and kept the water running through it for the greater part of the day, examining the contents of the net at frequent intervals so as to have gatherings of two hours, three hours, or four hours

duration. The bath gatherings were, of course, always much smaller in quantity than those from the pipes outside, and I do not think that in any case they gave me an organism that I had not obtained in the other nets. On one occasion (September 27th) I obtained the first Radiolaria (*Acanthometra*) in an afternoon (1 to 3 p.m.) gathering from the bath, but they occurred also in the day's gathering examined at between 6 and 7 p.m., so that the utmost that can be claimed is that the bath gatherings showed that the Radiolaria were not necessarily collected late in the afternoon, but may have entered the net before 3 p.m.

Even in a case where the bath intermittent gatherings show either the presence or the absence of a particular organism temporarily, one should be cautious about drawing conclusions. Many of the pelagic organisms are very wide-spread over the Atlantic, or particular wide areas of it, and the temporary absence may be due to quite minor and irregularly acting causes, such as we usually term "accidental."

Each day I obtained a record of the temperature both of the water as it passed through my nets and also as drawn direct from the sea. As a rule, the water in the nets was from one to two degrees Fahrenheit higher than the sea. The highest temperature recorded was 60° F., and the lowest 37° F. In crossing the Atlantic from Ireland the temperature got higher daily till about long. 30° W., then fell as we approached and went through the Labrador current, and rose again (from 50° F. to 60° F. in 24 hours) after passing through the Straits of Belle Isle.

In coming back, at the end of September, the temperature fell as we passed down the St. Lawrence from 50° F. near the western end of Anticosti, to 37° F. outside the Straits of Belle Isle, in the Labrador current. Then it rose steadily as we got further across the Atlantic and

more into the easterly drift of water that continues the influence of the Gulf Stream up to the Irish coast. On successive days the average temperature was 37°, 49°, 49°, 52°, 54°, and 55° F.

The influence of the change of temperature upon the organisms was most marked, especially in the case of the cold Labrador current, outside the Straits of Belle Isle. In this case, if we had had no thermometer, and had not been able from fog or other reasons to ascertain our position, I believe it would have been possible to recognise that we had entered the Labrador current by the microscopic contents of the tow-nets.

It is a question how far the Gulf Stream can be said to influence the surface fauna in the latitudes where we crossed the N. Atlantic. Although no longer a clearly marked warm current east of long. 40° W., still it merges into, or is continued onwards as, a surface drift of warmer water (due to the prevalent winds) eastwards and northwards to the British Islands and to the coast of Norway, reinforced perhaps by Rennell's current coming up from the Bay of Biscay. In this way the Atlantic drift current, whether called Gulf Stream or not, must have considerable influence upon the nature of the plankton in the north-eastern part of the Atlantic, and we know that pelagic organisms more commonly found in regions further south and west are not infrequently carried to the west coasts of Ireland and Scotland.

The surface fauna of the Gulf Stream has been explored by Mr. Alexander Agassiz and other American naturalists, while the northern part and the southern sub-tropical part of the North Atlantic have been more or less thoroughly investigated by the Prince of Monaco, the naturalists of the German Plankton Expedition, and others; but there is a large central area between west longitudes 20° and 45°

and north of latitude 45° nearly to 60°, where few, if any, observations have been taken. Otto Pettersson and Cleve in their recently published charts mark this region "Okändt," and it is interesting to find that our two traverses in the "Parisian" went right through the length of this "unknown" region. Dr. John Murray made a traverse of the North Atlantic in this part in 1892, but he tells me that, although he gave some of the results in lectures at Boston, he has never published the details of his work. Consequently, we believe the present to be the first complete account published of a continuous traverse across the North Atlantic.

List of the Gatherings, with the Organisms Observed in Each.

By W. A. Herdman, I. C. Thompson, and Andrew Scott.

The outward gatherings are numbered from 1 to 17 consecutively in Arabic numerals, and each number indicates what was gathered during one day or one night, irrespective of the number of nets used and of the number of bottles filled. Where the contents of the different nets were kept separate, the lists are marked (A), (B) &c. The gatherings taken on the homeward journey are labelled from I. to XXIV. in Roman numerals. In some cases the nets at the tap and at the overflow pipe are numbered separately. The gatherings taken from the bath tap are marked **A, B, C**, &c.

The latitudes and longitudes at the times of emptying the nets have been calculated from the position of the ship at noon each day on the assumption that the ship ran equal distances in equal periods of time during the 24 hours.

As the species of Copepoda are more numerous than the other organisms, we have thought it more convenient to place the Copepoda at the end of each list rather than in their zoological position about the middle

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OUTWARD JOURNEY—LIVERPOOL to QUEBEC.

1. August 5th, 9 p.m., to August 6th, 8 a.m. From 50 miles off Liverpool to about Rathlin Island, Ireland. Water slightly phosphorescent; no *Ceratium* observed; an ordinary Irish sea gathering, containing:—

Fish eggs.
Gastropod larvæ.
Limacina retroversa.
Nyctiphanes norvegica (small).
Nauplei, and Zoeas (Crab).
Amphipoda (fragments).
Philomedes interpuncta.
Sagitta bipunctata.
Mitraria larva.
Medusoids (small).
Campanularians (broken)

Many Copepoda, including:—

Oithona spinifrons (common).
Calanus finmarchicus (common).
Paracalanus parvus (few).
Temora longicornis (few).
Acartia clausii (few).
Metridia armata (rare).
Pseudocalanus elongatus (few).
Centropages hamatus (few).
C. typicus (few).
Anomalocera patersonii (few).
Longipedia coronata (rare).
Ectinosoma atlanticum (rare).

Thalestris serrulata (rare).
Alteutha interrupta (rare).

2. August 6th, 11 a.m. to 3 p.m.; at anchor in Lough Foyle, Ireland. Very little plankton, few Copepoda.

Coscinodiscus radiatus.
Rotalia beccarii.
Autolytus sp.
Larval Annelid.
Mitraria larva.
Mysis stage of *Crangon.*
Loxoconcha impressa
Idotea marina.
Fragments of *Balanus* and of Zoophytes.
Gastropod larvæ.
Fish egg (large).

The Copepoda were:—

Acartia clausii (common).
Calanus finmarchicus (common).
Pseudocalanus elongatus (common).
Temora longicornis (few).
Centropages hamatus (few).
Oithona spinifrons, and some larval forms.

3. August 6th, 4 p.m. to 7 p.m.; off north-west coast of Ireland; from off Moville, Lough Foyle, to lat. 55° 40′ N., long. 8° 50′ W. Many Copepoda.

Ceratium fusus.
Rhizosolenia sp.
Mitraria larva.
Larval Annelids.
Zoea and Megalopa of Crab.
Mysis stage of *Crangon.*
Fragments of *Balanus.*
Limacina retroversa (swarm).

The Copepoda were:—

Calanus finmarchicus (common).
Centropages typicus (few).
C. hamatus (few).
Metridia armata (rare).
Paracalanus parvus (rare).
Acartia clausii (few).
Oithona spinifrons (common).

4. August 6th, 9 p.m., to August 7th, 9 a.m.; from lat. 55° 40′ N., long. 8° 50′ W., to lat. 56° 15′ N., long. 14° 30′ W.

Globigerina bulloides.
Orbulina universa.
Acanthometra pellucida.
Sphærozoum punctatum.
Limacina retroversa.

Copepoda:—Nauplei, and

Calanus finmarchicus (common).
Acartia clausii (common).
Oithona spinifrons (common).
Metridia armata (few).
Centropages typicus (few).

5. August 7th, 9 a.m. to 7 p.m.; from lat. 56° 15′ N., long. 14° 30′ W., to lat. 56° 30′ N., long. 18° W.; quantity, ·75 cc., mainly Copepoda.

Globigerina bulloides.
Polystomella striato-punctata.
Sphærozoum punctatum.
Acanthometra pellucida.
Ceratium tripos.
Diatoms.
Limacina retroversa.

Copepoda :—

Calanus finmarchicus (common).
Centropages typicus (few).
Acartia clausii (abundant).
Oithona spinifrons (common).

6. August 7th, 7 p.m., to August 8th, 9 a.m.; from lat. 56° 30′ N., long. 18° W., to lat. 56° 30′ N., long. 24° 22′ W.; quantity, 5 cc.

Orbulina universa.
Globigerina bulloides (many).
Acanthometra pellucida.
Sphærozoum punctatum.
Halosphæra viridis.
Coscinodiscus radiatus.
Limacina retroversa.
Fish eggs and embryos.
Conchœcia spinirostris.

Copepoda, many larvæ and

Calanus finmarchicus (common).
Acartia clausii (many).
A. discaudata (rare).
Centropages typicus (few).
Oithona spinifrons (few).
Pleuromma abdominale (few).
Oncea venusta (rare).

7. August 8th, 9 a.m. to 6 p.m.; from lat. 56° 30′ N., long. 24° 22′ W., to lat. 56° 22′ N., long. 28° 8′ W.; temperature 56° F; quantity, 3·5 cc.

Globigerina bulloides.
Acanthometra pellucida.
Sphærozoum punctatum.
Ceratium tripos.
(?) *Pyrocystis.*

Segmenting invertebrate eggs.
Fish eggs.
Nauplei.
Evadne nordmanni.

Copepoda (many) :—
Oithona spinifrons (common).
Calanus finmarchicus (few).
Acartia clausii (common).
Centropages typicus (few).
Anomalocera patersonii (rare).

8. August 8th, 7 p.m., to August 9th, 9 a.m.; from lat. 56° 22′ N., long. 28° 8′ W., to lat. 56° 28′ N., long. 34° 25′ W.; quantity 5 cc.

Globigerina bulloides.
Acanthometra pellucida.
Sphærozoum punctatum.
Ceratium tripos.
C. fusus.
Peridinium divergens.
Limacina retroversa.

Nauplei, and the following Copepoda :—
Nogagus borealis (rare).
Calanus finmarchicus (common).
Pleuromma abdominale (few).
Oithona spinifrons (few).
Acartia clausii (common).

9. August 9th, 10 a.m. to 6 p.m.; from lat. 56° 28′ N., long. 34° 25′ W., to lat. 56° 8′ N., long. 38° 6′ W.; 5 cc. Much yellow debris (*Trichodesmium*, &c., remains and fragments), which stained the nets yellow-brown, and clogged up the meshes of the finer ones.

Peridinium divergens (very abundant).
P. globosus.

Dinophysis atlantica.
Ceratium tripos (abundant).
C. fusus.
Globigerina bulloides.
Coscinodiscus radiatus.
Trichodesmium erythræum (very abundant).

Copepoda, few, some larvæ :—
Oithona spinifrons (common).
Ectinosoma atlanticum (few).

10. August 9th, 7 p.m., to August 10th, 9 a.m.; from lat. 56° 8′ N., long. 38° 6′ W., to lat. 55° 22′ N., long. 44° 11′ W. Nets kept separate.

(A.) Nets on overflow pipe (large gatherings); 200 cc.:—

Ceratium tripos.
Peridinium divergens.
Coscinodiscus radiatus.
Sagitta sp.
Limacina retroversa.
Cliona borealis.
Halocypris atlantica.
Conchœcia spinirostris.
Euthemisto compressa (many young).

Copepod, Nauplei and
Calanus finmarchicus (great abundance).
Heterochæta spinifrons (rare).
Euchæta marina (few).
Oithona spinifrons (few).
Scolecithrix danæ (rare).

(B.) Nets on tap, with much less material (12 cc.) and smaller forms :—

Peridinium divergens (very abundant).
Ceratium tripos.

Coscinodiscus radiatus.
Euthemisto compressa.
Limacina retroversa.
Copepoda :—
Calanus finmarchicus (common).
Oithona spinifrons (few).
Ectinosoma atlanticum (few).

11. August 10th, 9 a.m. to 6 p.m.; from lat. 55° 22′ N., long 44° 11′ W., to lat. 54° 30′ N., long. 47° 28′ W.; 51° F.

Nets on overflow pipe had quantities of large red *Calanus finmarchicus;* the nets on tap had only a few *Calanus,* and the outer finer net had only Diatoms and Dinoflagellates; 30 cc. in all.

Coscinodiscus radiatus.
Ceratium tripos.
Peridinium divergens.
Globigerina bulloides.
Sagitta sp.
Annelid larva (?)
Euthemisto compressa.
Nyctiphanes norvegica.
Copepod Nauplei, and
Calanus finmarchicus (common).
Euchaeta marina (few).
Oithona spinifrons (few).

12. August 10th, 7 p.m., to August 11th, 9 a.m.; from lat. 54° 30′ N., long. 47° 28′ W., to lat. 52° 55′ N., long. 52° 40′ W.; 125 cc.

The coarser net on overflow pipe had the very large red *Calanus* and *Euchæta,* and a few large Amphipods. The finer net had a large mass of grey stuff, chiefly Copepoda. The coarser net on the tap had a number of red *Calanus* and *Euchæta,* and some larval Schizopods, while the

finer net on the tap had *Ceratium*, *Peridinium*, and other minute forms.

Ceratium tripos (two forms).
Peridinium divergens.
P. sp.
Coscinodiscus radiatus.
Globigerina bulloides (a few, very small).
Annelid larva.
Conchœcia spinirostris.
Euthemisto compressa.
Larval Schizopods.
Limacina retroversa.
Copepod Nauplei, and eggs :—
Calanus finmarchicus (very many).
Euchæta marina (few).
Oithona spinifrons (many).
Heterochæta spinifrons (rare).
Pseudocalanus elongatus (common).

13. August 11th, 9 a.m. to 6 p.m. ; from lat. 52° 55′ N., long. 52° 40′ W., to lat. 51° 55′ N., long. 55° 46′ W. ; temperature in sea, 47° to 50° during day ; in tub, 52° F.

Peridinium divergens.
Ceratium tripos (two forms).
C. fusus.
Globigerina bulloides.
Coscinodiscus radiatus.
Cypris stage of *Balanus.*
Sagitta sp.
Cliona borealis.
Limacina retroversa.
Fish eggs.
Decapod Zoea (many large).
Microniscus calani (parasitic on Calanus).
Euthemisto compressa (few, large).

Copepoda :—

Calanus finmarchicus (very few).
Oithona spinifrons (few).
Euchæta marina (few).
Centropages hamatus (few).
Pseudocalanus elongatus (common).
Temora longicornis (few).

14. August 11th, 7 p.m., to August 12th, 9 a.m.; from lat. 51° 55′ N., long. 55° 46′ W., to lat. 49° 37′ N., long. 59° 50′ W.; temperature in tub, 62° F.

(A.) The finer net at overflow pipe (45 cc.) :—

Coscinodiscus radiatus.
Ceratium tripos.
C. fusus.
Peridinium divergens.
Globigerina bulloides.
Sagitta sp. (great quantity).
Euthemisto compressa.
Nyctiphanes norvegica (?).
Zoea of Crab.
Cypris stage of *Balanus.*
Mysis stage of Schizopods.
Fish eggs.

Copepoda, many :—

Calanus finmarchicus (very few).
Temora longicornis (few).
Ectinosoma atlanticum (many).
Acartia denticornis (?) (rare).
Oithona spinifrons (many).
Pseudocalanus elongatus (many).
Centropages hamatus (few).
Corynura discaudata, n. sp. (rare),

(B) The coarser net at overflow pipe (35 cc.) :—

Euthemisto compressa (many large).
Zoea of Crab.
Fish eggs, and some small fishes (damaged).
Limacina retroversa.
Calanus finmarchicus (many).
Anomalocera patersonii (few).

(C) Nets at tap (12 cc.) :—

Ceratium tripos (abundant).
C. fusus.
Peridinium divergens.
Coscinodiscus radiatus.
Zoea of Crab.

Copepoda :—

Calanus finmarchicus (common).
Oithona spinifrons (many).
Temora longicornis (few).
Centropages hamatus (few).
Pseudocalanus elongatus (common).
Ectinosoma atlanticum (rare).
Thalestris serrulata (rare).

15. August 12th, 9 a.m. to 6 p.m. ; from lat. 49° 37′ N., long. 59° 50′ W., to lat. 48° 50′ N., long. 62° 50′ W.

Less in nets than in the morning (20 cc.) :—

Ceratium tripos (very many).
C. fusus.
Peridinium divergens.
Coscinodiscus radiatus.
Sagitta sp. (few).
Euthemisto compressa.
Zoea of Crab.
Cypris stage of *Balanus*.
Evadne nordmanni.
Limacina retroversa.

Small Clupeoid fish (several).

Copepoda :—

Corynura discaudata, n. sp. (rare).

Centropages hamatus (few).

Oithona spinifrons (common).

Anomalocera patersonii (few).

Pseudocalanus elongatus (common).

Calanus finmarchicus (common).

Temora longicornis (few).

Ectinosoma atlanticum (rare).

Eurytemora herdmani, n. sp. (rare).

16. August 12th, 7 p.m., to August 13th, 9 a.m. ; from lat. 48° 50′ N., long. 62° 50′ W., to lat. 49° N., long. 67° 45′ W. Coarser net on overflow pipe gave the largest haul as yet, consisting chiefly of *Calanus* and *Euthemisto*.

(A) Nets on overflow pipes (175 cc.) :—

Ceratium tripos.

Peridinium divergens.

Mysis stage of *Crangon*.

Cypris stage of *Balanus*.

Podocerus variegatus.

Evadne nordmanni.

Euthemisto compressa.

Sagitta sp.

Zoea of Crab.

Nyctiphanes norvegica.

Copepoda, many, small :—

Calanus finmarchicus (few).

Pseudocalanus elongatus (many).

Oithona spinifrons (common).

Euchæta marina (few).

Acartia longiremis (few).

A. forcipata, n. sp. (rare).

A. denticornis (?) (rare).
Temora longicornis (few).
Eurytemora herdmani, n. sp. (rare).
Centropages hamatus (few).
Pleuromma abdominale (rare).
Ectinosoma atlanticum (rare).

(B) Nets at tap (30 cc.) :—
Coscinodiscus radiatus.
Globigerina bulloides.
Lamellibranch fry.
Cypris stage of *Balanus.*
Zoea of Crab.
Fish eggs.

Copepoda :—
Calanus finmarchicus (common).
Pseudocalanus elongatus (common).
Oithona spinifrons (common).
Temora longicornis (few).
Eurytemora herdmani, n. sp. (rare).
Corynura discaudata, n. sp. (few).
Acartia longiremis (few).
A. denticornis (?) (rare).
Centropages hamatus (few).

17. August 13th, 9 a.m. to 6 p.m.; from lat. 49° N., long, 67° 45′ W., to 90 miles from Quebec (40 cc.) :—
Coscinodiscus radiatus.
Ceratium tripos.
Peridinium globosus.
Evadne nordmanni.
Podocerus variegatus.
Cypris stage of *Balanus.*
Schizopod fragments.
Euthemisto compressa.

Microniscus calani.
Sagitta sp.
Zoea of Crab.
Leptocephalids.
Copepoda :—
Calanus finmarchicus (common).
Pseudocalanus elongatus (common).
Eurytemora affinis (few).
E. herdmani, n. sp. (common).
Acartia longiremis (few).
A. clausii (common).
A. denticornis (rare).
A. forcipata, n. sp. (rare).
Euchæta marina (few).
Temora longicornis (few).
Ectinosoma sarsii (rare).
Oithona spinifrons (few).

HOMEWARD JOURNEY—QUEBEC TO LIVERPOOL.

In addition to the nets on the overflow pipe and on the tap as before, a fine silk net was now placed on the tap in the bathroom, which was to be worked intermittently. The bath gatherings are labelled **A, B, C,** &c.

I. September 26th, 9 a.m. to 6 p.m. From Quebec down the St. Lawrence to 30 miles west of Rimouski. Much fine mud with many *Coscinodiscus radiatus;* also:—

Ceratium tripos.
Chydorus sphæricus.
Bosmina longirostris.
Copepoda a few, including:—
Calanus finmarchicus (common).
Pleuromma abdominale (few).
Oithona spinifrons (few).

Oncea conifera (rare).
Ectinosoma sarsii (rare).
Acartia longiremis (abundant).
Eurytemora affinis (common).
E. herdmani, n. sp. (common).
Pseudocalanus elongatus (abundant).

A, on bath tap, September 26th, 12 to 5 p.m. (phosphorescent).

A small gathering included in above list.

II. September 26th, 7 p.m., to September 27th, 9 a.m.; from 30 miles west of Rimouski, to lat. 49° 12′ N., long. 64° 50′ W.

Peridinium divergens.
Ceratium fusus.
C. tripos.
Tintinnus denticulatus.
Coscinodiscus radiatus (few).
Chaetoceros (several species).
Other Diatoms and Algæ.
Nyctiphanes norvegicus.

Copepoda, Nauplei, and
Calanus finmarchicus (abundant).
Pleuromma abdominale (common).
Pseudocalanus elongatus (common).
Oithona spinifrons (common).
Temora longicornis (few).
Centropages hamatus (few).
Euchæta marina (few).
Thalestris serrulata (rare).

B, on bath tap, September 27th, 6 a.m. to 9 a.m.

[Very little—some fine sand.]

Diatoms, and *Calanus finmarchicus* (a few).

III. September 27th, 9 a.m. to 5-30 p.m.; from lat. 49° 12′ N., long. 64° 50′ W., to lat. 48° 50′. N., long. 61° 20′. W., (Gulf of St. Lawrence, opposite Anticosti). Diatoms (a good deal of brown stuff, chiefly diatoms), also Coccospheres (few) ; temp. 50° F.

Ceratium tripos (common).
C. fusus (many), and *C. furca* (few).
Peridinium divergens, and *P. globosus.*
Tintinnus denticulatus, and *T. fistularis.*
T. campanula, and *T. serratus.*
Dictyocha speculum.
Coscinodiscus radiatus.
Chaetoceros atlanticus (very many).
Halosphæra viridis.
Haliomma sp., and *Acanthometra.*
Dinophysis atlantica.
Rotalia beccarii.
Globigerina bulloides.
Sagitta sp., and Lamellibranch fry.

Copepoda :—*Calanus finmarchicus* (common).
Acartia laxa (several).
Oithona spinifrons (common).

C, on bath tap, September 27th, 1 to 3 p.m.
Very little material; some Diatoms, and :—
Acanthometra pellucida.
Peridinium divergens, and *P.* sp.
Ceratium fusus, and *C. tripos.*
Nauplei and small Copepoda (*Oithona*).
Lamellibranch fry.

IV. September 27th, 6 p.m., to September 28th, 9 a.m; from lat. 48 50′ N., long. 61 20′ W., to lat. 51 N., long. 57 40′ W.

Ceratium tripos (common), and *C. fusus.*

Tintinnus denticulatus (common).
Halosphæra viridis.
Peridinium divergens.
Sagitta sp. (many).
Amphipoda.
Megalopa of Crab.
Nyctiphanes norvegica.
Lamellibranchs (fry).
Young fish (Leptocephalid ?).

Copepoda many (also Nauplei and eggs) :—
Calanus finmarchicus (common).
Acartia longiremis (abundant).
Pleuromma abdominale (common).
Pseudocalanus elongatus (common).
Oithona spinifrons (common).

D, on bath tap, September 28th, 6 a.m to 9 a.m. Moderate amount, same as **IV**.

E. on bath tap, September 28th, 1 to 4 p.m. (going through Straits of Belle Isle, cold, sea temp. 37° F.).
Ceratium tripos (great quantity).
Peridinium divergens, and *Halosphæra viridis.*
Diatoms (*Coscinodiscus, Chætoceros*, &c.).
Tintinnus denticulatus, and *Codonella orthoceras.*
Globigerina bulloides.
Dictyocysta atlantica.
Limacina retroversa.

Copepoda (few small) and Nauplei :—
Calanus finmarchicus (common).
Oithona spinifrons (common).

V. September 28th, 9 a.m. to 6 p.m.; from lat. 51° N., long. 57°40′ W., to lat. 52°8′ N., long. 54°30′ W.
Ceratium tripos, and *Peridinium divergens.*
Tintinnus denticulatus, and *Codonella orthoceras.*

Diatoms (*Coscinodiscus*, &c.) and *Halosphæra*.
Limacina retroversa.
Nauplei, and Megalopa (large).
Copepoda :—*Calanus finmarchicus* (abundant).
Pseudocalanus elongatus (abundant).
Oithona spinifrons (abundant).

VI. September 28th, 7 p.m., to September 29th, 9 a.m.; from lat. 52° 8′ N., long. 54° 30′ W., to lat. 53° 25′ N., long. 49° 20′ W. (Very large gathering, phosphorescent.)

Ceratium tripos (common), and *Chætoceras*.
Peridinium divergens (common).
Tintinnus denticulatus, and *Codonella orthoceras*.
Megalopa of Crab.
Copepoda :—*Calanus propinquus* (common).
*C. finmarchicus** (masses of large, red).
Pseudocalanus elongatus (abundant).
Oithona spinifrons (common).

F, on bath tap, September 29th, 7 to 11 a.m.
Ceratium tripos, and *Coscinodiscus radiatus*.
Peridinium divergens (2 varieties).
Tintinnus denticulatus, and *Codonella orthoceras*.
Globigerina bulloides.
Calanus finmarchicus (few).

VII. September 29th, 9 a.m. to 6 p.m.; from lat. 53° 25′ N., long. 49° 20′ W., to lat. 54° 15′ N., long. 46° 22′ W.; temp. 49° F.

Ceratium tripos, and *C. furca* (abundant).
Peridinium sp. (common).
Tintinnus denticulatus (common).
Codonella campanella.
Globigerina bulloides (abundant).
Coscinodiscus radiatus (common).

* Some of these were cooked by Mrs. William Ramsay, and were eaten by the captain and a number of the passengers (see NATURE, vol 56, p. 565).

Coccospheres (few).
Limacina retroversa (many).
Copepoda:—*Calanus finmarchicus* (common).
C. propinquus (few).
Temora longicornis (several).
Oithona spinifrons (common).

G, on bath tap, September 29th, 1 to 4 p.m.
Ceratium tripos, & *Globigerina bulloides* (many).

VIII. September 29th, 7 p.m., to September 30th, 9 a.m.; from lat. 54° 15′ N., long. 46° 22′ W., to lat. 55° 24′ N., long. 41° 10′ W.

Peridinium divergens (very many*).
Coccospheres & *Coscinodiscus radiatus* (common).
Tintinnus denticulatus (few).
Ceratium tripos (few).
Do., variety (?) (abundant).
Dinophysis atlantica (abundant).
Globigerina bulloides (few).
Limacina retroversa.
Copepoda:—*Calanus propinquus* (abundant).
(?) *Pleuromma abdominale*.
Temora longicornis (few).
(?) *Ectinosoma atlanticum*.
Oithona spinifrons (abundant).

H, on bath tap, September 30th, 7 to 11 a.m. (Small quantity, in the main same as above.)
Ceratium tripos (abundant).
Peridinium divergens (abundant).
Tintinnus denticulatus (few).

* This *Peridinium* was so abundant and so red in colour as to give the silk of the nets a reddish tint, and to cause a deposit looking like a fine red powder (recalling the appearance of Dr. Gregory's mixture) at the bottom of the collecting dish.

Coscinodiscus radiatus (common).
Globigerina bulloides (few).
Copepoda:—*Calanus propinquus* (few).
Pleuromma abdominale (few).
Oithona spinifrons (few).
Ectinosoma atlanticum (few).

IX. September 30th, 9 a.m. to 6 p.m.; from lat. 55° 24′ N., long. 41° 10′ W., to lat. 55° 50′ N., long. 38° W. (Comparatively little, much same forms as in morning.)

Peridinium divergens (abundant).
Ceratium tripos (abundant), several varieties.
Dinophysis atlantica (many).
Tintinnus denticulatus.
Coccospheres & *Coscinodiscus radiatus* (common).
Globigerina bulloides (few).
Limacina retroversa..
Copepoda:—*Calanus propinquus* (common).
Oithona spinifrons (common).

I, on bath tap, September 30th, 1 to 6 p.m.

Coscinodiscus radiatus (common).
Tintinnus denticulatus (few).
Peridinium divergens (abundant).
Dinophysis atlantica (few).
Ceratium tripos (abundant), several varieties.
Globigerina bulloides (few).
Copepoda:—*Calanus propinquus* (common).
Pleuromma abdominale (few).
Oithona spinifrons (few).

X. September 30th, 7 p.m., to October 1st, 10 a.m.; from lat. 55° 50′ N., long. 38° W., to lat. 56° 10′ N., long. 31° 40′ W. (Rather more material than usual.

Peridinium divergens (very large).
Ceratium tripos (abundant), several forms.

C. fusus, and *C. furca* (few).
Dinophysis atlantica (common).
Podosira montagnei (few).
Tintinnus denticulatus.
Acanthometra pellucida.
Coccospheres.
Coscinodiscus radiatus.
Globigerina bulloides (many).
Limacina retroversa.

Copepoda (many small), including
Calanus finmarchicus (abundant).
Pleuromma abdominale (few).
Euchæta marina (few).
Heterochæta spinifrons (few).
Oithona spinifrons (abundant).

J. on bath tap, October 1st, 7 a.m. to noon.
Ceratium tripos.
Acanthometra pellucida (several).
Globigerina bulloides (many).

XI. October 1st, 10 a.m. to 6 p.m.; from lat. 56° 10′ N., long. 31° 40′ W., to lat. 56° 20′ N., long. 28° 24′ W.

Globigerina bulloides (many).
Dictyocha speculum.
Dinophysis atlantica.
Tintinnus denticulatus.
Coscinodiscus radiatus.
Peridinium divergens (many).
Ceratium tripos (few).
Do. var. *arcuatum* (common).
C. furca, and *C. fusus* (few).
Podosira montagnei.
Limacina retroversa.
Acanthometra pellucida.

Copepoda :—*Calanus finmarchicus* (common).
Acartia longiremis (common).
Pleuromma abdominale (several).
Pseudocalanus elongatus (common).
Oithona spinifrons (common).

XII. October 1st, same locality; another net on overflow pipe; 12 to 6 p.m.

Ceratium tripos (few).
Coscinodiscus radiatus (few).
Tintinnus denticulatus.
Globigerina bulloides.
Acanthometra pellucida.
Radiolaria (several), *Amphibelone,* sp.
Limacina retroversa (abundant).
Schizopoda (few, damaged, (?) *Euphausia*).
Euthemisto compressa (few).
Copepoda :—*Acartia longiremis* (common).
Pseudocalanus elongatus (common).
Oithona spinifrons (common).

K, on bath tap, October 1st, 1 to 6 p.m. Some of the commoner forms in **XI.**

XIII. October 1st, 6 p.m., to October 2nd, 9 a.m.; from lat. 56° 20′ N., long. 28° 24′ W., to lat. 56° 30′ N., long. 22° W. Nets at overflow pipe.

Globigerina bulloides (few).
Sagitta sp. (few).
Nauplei.
Euthemisto compressa (abundant).
Euphausia (?) *inermis* (abundant).
Limacina retroversa (very many).
Small fish (damaged).
Copepoda (many small, white).
Acartia longiremis (few).

Pleuromma abdominale (abundant).
Euchæta marina (common).
Centropages typicus (common).

XIV. October 1st to 2nd, same time and locality as last. Nets at tap.

Ceratium tripos (common).
C. fusus, and *C. furca* (few).
C. globosum (common).
Peridinium divergens.
Coccospheres (several).
Globigerina bulloides (abundant).
Dictyocysta elegans.
Asterionella formosa (several).
Dinophysis atlantica.
Dictyocha speculum.
Radiolaria (*Haliomma, Acanthometra*).
Limacina retroversa, and *Creseis acicula.*
Sagitta sp. (several).

Copepoda :—*Calanus finmarchicus* (few).
C. tonsus (few).
Acartia longiremis (abundant).
Pleuromma abdominale (common).
Scolecithrix danæ, and *S. minor* (several).
Centropages hamatus (few).
Oithona spinifrons (common).
Ectinosoma atlanticum (few).

L, on bath tap, October 2nd, 7 a.m. to 3 p.m.
Globigerina bulloides.
Acanthometra pellucida.
Peridinium divergens.
Dictyocysta elegans.
Creseis acicula
Limacina retroversa.

Copepoda (small), *Acartia longiremis.*

XV. October 2nd, 9 a.m. to 7 p.m.; from lat. 56° 30′ N., long. 22° W., to lat. 56° 22′ N., long 18° 43′ W. Nets on overflow pipe.

Acanthometra pellucida (few).
Globigerina bulloides (few).
Peridinium divergens.
Ceratium tripos.
Euphausia sp. (many young).
Euthemisto compressa (all immature, abundant).
Hyperia promontorii, Steb.
Sagitta sp. (few).
Creseis acicula.
Young Syngnathid fish.

Copepoda, many small, including:—
Acartia longiremis (abundant).
Centropages hamatus (few).

XVI. October 2nd, same time and locality as **XV**. Nets at tap (brilliantly phosphorescent).

Peridinium divergens.
Ceratium tripos (common), several varieties.
C. fusus (common), and *C. furca* (common).
Globigerina bulloides (common).
Haliomma sp.
Stylodictya heliospira (?).
Pteropods.

Copepoda:—*Calanus finmarchicus*, and *C. tonsus*
Acartia longiremis, and *A. discaudatus.*
Pseudocalanus elongatus (abundant).
Euchæta philippi (several).
Centropages typicus (common).
Oithona spinifrons (common).
Ætidius armatus (several).

M, on bath tap, October 2nd, 3 p.m. to 7 p.m.
Globigerina bulloides.

Radiolaria (*Haliomma*).
Peridinium divergens.
Ceratium tripos, and var. *macroceros.*
C. furca, and *C. fusus.*
Larval Schizopods.
Limacina retroversa.
Copepoda (small):—*Acartia longiremis.*
Calanus finmarchicus.
Oithona spinifrons.
Pseudocalanus elongatus.
Centropages hamatus, and *C. typicus.*

XVII. October 2nd, 8 p.m., to October 3rd, 9 a.m.; from lat. 56° 22′ N., long. 18° 43′ W., to lat. 56° 5′ N., long. 12° 30′ W. Nets on overflow pipe (many large Crustacea).

Globigerina bulloides (common).
Ceratium tripos (many).
Sagitta sp.
Limacina retroversa.
Small Syngnathid fish.
Euthemisto compressa (common).
Nyctiphanes norvegica (common).
Copepoda:—*Calanus finmarchicus* (few).
C. propinquus (few).
Acartia longiremis (common).
Pleuromma abdominale (common).
Pseudocalanus elongatus (common).
Euchæta marina (few).
Centropages typicus (common).
Eucalanus attenuatus (few).
Ætidius armatus (few).

XVIII. October 2nd and 3rd; same time and locality as last. Nets at tap (all fine stuff).

Ceratium tripos (many).

C. fusus (common), and *C. furca* (common).
Acanthometra pellucida (few).
Globigerina bulloides.
Stephanomonas quadrangularis.
Dictyocha speculum and *D. fibula.*
Peridinium divergens (sev. varieties).
Tintinnus acuminatus, and *T. denticulatus.*
Dinophysis atlantica.
Dictyocysta templum (?), and *D. elegans.*
Coccospheres.
Coscinodiscus radiatus, and other Diatoms.
Limacina retroversa.

Copepoda :—*Calanus finmarchicus* (abundant).
Acartia longiremis (abundant).
Metridia armata (common).
Centropages typicus (common) & *C. hamatus* (few).
Oithona spinifrons.

N, on bath tap, October 3rd, 7 a.m. to noon. Small gathering, much the same as finer net at tap in above.

Ceratium tripos, C. fusus, and *C. furca.*
Peridinium divergens and *P. globosus.*
Acanthometra pellucida.
Globigerina bulloides.
Dictyocysta templum (?).
Coscinodiscus radiatus.
Tintinnus denticulatus.

Copepoda as follows :—
Calanus finmarchicus (few).
Centropages hamatus (few).
Acartia longiremis (abundant).
Oithona spinifrons (common).
Pseudocalanus elongatus (abundant).

O, on bath tap, October 3rd, 1 p.m. to 5 p.m. Same as last.

XIX. October 3rd, 9 a.m. to 6 p.m.; from lat. 56° 5′ N., long. 12° 30′ W., to 20 miles north of Tory Island. Nets at overflow pipe.

Medusæ (torn).
Peridinium divergens.
Dictyocysta elegans.
Dictyocha fibula.
Ceratium tripos and *C. furca.*
Globigerina bulloides (common).
Radiolaria (*Haliomma*, &c.).
Podon intermedium (few.)

Copepoda many, including:—
Calanus finmarchicus (abundant).
Acartia longiremis (abundant).
Pseudocalanus elongatus (common).
Centropages typicus (common).

XX. October 3rd, same time and locality as **XIX.** Nets at tap (much small stuff).

Ceratium tripos, C. fusus, and *C. furca.*
Heliosphæra sp.
Acanthometra pellucida.
Dictyocha speculum, and *D. fibula.*
Dictyocysta elegans.
Globigerina bulloides.
Peridinium divergens.
Coscinodiscus radiatus.

Copepod Nauplei, and
Calanus finmarchicus (abundant).
Pseudocalanus elongatus (common).
Candace pectinata (scarce).
Metridia armata (common).
Oithona spinifrons (few).
Acartia longiremis (abundant).

Centropages typicus (few).
C. hamatus (few).

P, on bath tap, October 3rd, 5 p.m., to October 4th, 10 a.m. (off Port Erin).

Ceratium tripos, *C. fusus*.
Peridinium divergens.
Dictyocysta elegans.
Diatoms.
Globigerina bulloides.

Copepoda :—

Calanus finmarchicus (common).
Centropages hamatus (few).
Metridia armata (few).
Pseudocalanus elongatus (common).
Oithona spinifrons (few).
Acartia longiremis (few).
Isias clavipes (scarce).

XXI. and **XXII.** October 3rd, 7 p.m., to October 4th, 9 a.m.; from 20 miles north of Tory Island to 15 miles west of Peel. Great deal of material. Part of it porbably from entrance to Lough Foyle, where we stopped for an hour at midnight. Nets at overflow pipe had Sagitta, Medusæ, Amphipoda, and the larger Copepoda; nets at tap had much finer stuff—the Protozoa and the smaller Copepoda.

Ceratium tripos (few).
C. fusus (few).
Navicula sp.
Dictyocysta elegans.
Globigerina bulloides.
Unicellular Algæ.
Medusæ (small).
Sagitta sp. (abundant).

Megalopa.
Gastrosaccus spinifer.
Hyperia galba.
Euthemisto compressa (common).

Copepoda many, including:—
Calanus finmarchicus (common).
Acartia longiremis (common).
Metridia armata (common).
Pseudocalanus elongatus (common).
Centropages hamatus (few).
C. typicus (few).
Anomalocera patersonii (few).

XXIII. October 4th, 9 a.m. to 2 p.m.; from 15 miles west of Peel to near Liverpool Bar. Nets at overflow pipe.

Sagitta bipunctata (abundant).
Ceratium tripos (common).
C. fusus (common), and *C. furca* (common).
Dictyocha speculum.
Coscinodiscus radiatus (common).
Globigerina bulloides (common).
Biddulphia sp. (common).

Copepoda many, including:—
Calanus finmarchicus (common).
Acartia longiremis (abundant).
Metridia armata (few.)
Pseudocalanus elongatus (abundant).
Centropages hamatus (few).
Isias clavipes (common).
Parapontella brevicornis (few).
Labidocera wollastoni (common).

XXIV. October 4th, same time and locality as **XXIII.** Nets at tap (fine stuff).

Ceratium tripos (abundant).

C. furca, and *C. fusus*.
Coscinodiscus radiatus.
Peridinium divergens.
Dictyocha speculum.
Tintinnus acuminatus.
Codonella campanula.
Halosphæra viridis.
Rotalia beccarii.

Copepoda :—
Calanus finmarchicus (common).
Acartia longiremis (common).
Metridia armata (few).
Pseudocalanus elongatus (few).
Temora longicornis (few).
Centropages typicus (few).
Labidocera wollastoni (common).
Oithona spinifrons (common).

NOTES on NEW and OTHER COPEPODA.

By I. C. THOMPSON and ANDREW SCOTT.

The collection comprises 39 species, of which three are described as new to science, as follows :—

LIST.	DISTRIBUTION.
Calanus finmarchicus (Gunner).	General.
C. propinquus, Brady.	Mid-Atlantic.
C. tonsus, Brady.	Mid-Atlantic.
Paracalanus parvus (Claus).	Off British coast.
Pseudocalanus elongatus (Boeck).	General.
Eucalanus attenuatus, Dana.	Mid-Atlantic.
Ætidius armatus, Brady.	Mid-Atlantic.
Euchæta marina (Prestandrea).	Mid-Atlantic
E. philippi, Brady.	Mid-Atlantic.
Scolecithrix danæ (Lubbock).	Mid-Atlantic.

S. minor, Brady.	Mid-Atlantic.
Centropages typicus, Kröyer.	British to Mid-Atlantic.
C. hamatus (Lilljeborg).	General.
Isias clavipes, Boeck.	Off British coast.
Temora longicornis (O. F. Müller).	General.
Eurytemora affinis (Poppe).	In St. Lawrence.
E. herdmani, n. sp.	In St. Lawrence.
Metridia armata, Boeck.	Off British coast.
Pleuromma abdominale (Lubbock).	General.
Heterochæta spinifrons, Claus.	Mid-Atlantic to Canada.
Candace pectinata, Brady.	Off British coast.
Labidocera wollastoni (Lubbock).	Off British coast.
Anomalocera patersonii, Templeton.	Off both coasts.
Parapontella brevicornis (Lubbock).	Off British coast.
Acartia clausii, Giesbrecht.	General.
A. longiremis (Lilljeborg).	General.
Acartia laxa, Dana.	Off Anticosti.
A. denticornis, Brady.	In St. Lawrence.
A. forcipata, n. sp.	In St. Lawrence.
Corynura discaudata, n. sp.	In St. Lawrence.
Oithona spinifrons, Boeck.	General.
Oncæa conifera, Giesbrecht.	In St. Lawrence.
O. venusta, Philippi.	In St. Lawrence.
Ectinosoma sarsii, Boeck.	In St. Lawrence.
E. atlanticum (Brady and Robertson).	All the way.
Longipedia coronata, Claus.	Irish Sea.
Thalestris serrulata, Brady.	Both coasts.
Alteutha interrupta (Goodsir).	Irish Sea.

Calanus finmarchicus has a world-wide distribution, having been recorded from the North Atlantic, Arctic Ocean, and European seas (Brady); Mediterranean, West Coast of South America, and Hongkong (Giesbrecht); Australasia and South Pacific (Brady); Sulu Sea (Dana).

It was found in nearly all the tow-nettings, and although considerable difference in size was noticed between various individuals, they did not appear to be structurally different. The largest specimens observed were in the material collected while traversing the Labrador current.

Calanus propinquus and *C. tonsus* were observed in a few of the gatherings in mid-ocean, where they appeared to take the place of *C. finmarchicus*.

Paracalanus parvus was found in the tow-nettings taken between Liverpool and the north coast of Ireland, but nowhere else.

Pseudocalanus elongatus, a very common species around our shores, occurred in nearly all the tow-nettings, and was even more numerous than *Calanus finmarchicus*. It is evidently common in the North Atlantic, although it has not hitherto been recorded from any locality outside European seas. In the case of many of the species the present collection has extended the known range of distribution.

Eucalanus attenuatus was observed in one only of the tow-nettings, taken near mid-ocean.

Ætidius armatus occurred in the same collection as *Eucalanus*; it was also taken on the previous day. This species, though widely distributed, was not known to occur in the Atlantic north of the Mediterranean, until quite recently. Mr. T. Scott records it from the Shetland-Faröe Channel. Other records for this Copepod are:—Indian Ocean, Torres Straits, off Port Jackson, and in the Chinese Sea (Brady); off Gibraltar (Giesbrecht), Malta (I. C. Thompson), Gulf of Guinea (T. Scott).

Euchæta marina was found in the majority of the collections taken between mid-ocean and Quebec. This is another species which appears to have a wide distribution, and more especially in tropical seas.

Euchæta philippi occurred sparingly in material collected between lat. 56° 22′ N., long. 18° 43′ W., and lat. 56° 5′ N., long. 12° 30′ W. It has hitherto only been known from the South Atlantic and South Pacific.

Scolecithrix danæ and *S. minor* were observed in material collected in mid-ocean on both traverses, but they occurred very sparingly. *S. minor* has already been recorded from North Atlantic waters, but there does not appear to be any record of *S. danæ* having been found north of the Mediterranean.

Centropages typicus occurred in the majority of the collections taken between the Irish sea and lat. 56° 30′ N., long. 24° 22′ W., to lat. 56° 22′ N., long. 28° 8′ W.

C. hamatus has apparently a more westerly distribution than *C. typicus*, and was found in the majority of the collections. The present collection shows a considerable extension of the distribution of these two species, especially the latter. So far neither of them have been recorded south of the Canary Islands. Mr. I. C. Thompson records *C. typicus* only from these Islands.

Isias clavipes was only found in the collection taken between Ireland and the Isle of Man. It is a common species in the L.M.B.C. district.

Temora longicornis occurred in the majority of the collections. There appears to be little difference between the forms from the British waters and those from the American coast, whereby the American forms could be ascribed to Dana's species, *T. turbinata*. The collection shows a considerable extension of distribution of this species.

The presence of *Eurytemora affinis* in considerable quantity between Quebec and Rimouski suggests a plentiful admixture of fresh water with the St. Lawrence in that neighbourhood, this being usually a brackish water species.

It has already been recorded from Minnesota (U.S.A), by C. L. Herrick, in his report on the Cyclopidæ of Minnesota, so that it would appear to be a widely distributed species. On the Continent of Europe, *E. affinis* sometimes occurs in immense profusion, constituting, it is said, at some seasons, the almost exclusive food of certain fishes, as of the Shad in the Rhine and the Herring in the Baltic.

A striking new species of *Eurytemora*, which is described and figured below as *E. herdmani*, was found in fair numbers in some gatherings in the St. Lawrence.

Pleuromma abdominale occurred plentifully, particularly amongst the plankton collected towards the other side, and in Mid-Atlantic, though sparingly taken in British waters. The distinguishing generic character, the dark coloured pleural eye, though generally present, was certainly entirely absent in many specimens, those with and those without the eye being found in the same gathering. Brady refers to the absence of the eye in many specimens. The nearly allied form, *Metridia armata*, was found generally distributed towards this side of the ocean. It is generally a very noticeable feature in plankton collections taken off the west Irish coast.

Heterochæta spinifrons was found very sparingly in collections taken between mid-ocean and Canada. The collection shows an extension of the distribution of this species in the North Atlantic.

Candace pectinata only occurred in a single gathering, the one taken between Rockall and the north coast of Ireland. North of the Mediterranean this species does not appear to have been taken anywhere else except round the British coasts, in several parts of which it has been recorded since Brady first described it from specimens collected at the Scilly Islands.

Labidocera wollastoni occurred in the collections made

in the Irish Sea on the homeward journey. It has already been recorded from this neighbourhood and about Puffin Island by Mr. Thompson.

Anomalocera patersonii was found rather plentifully in a gathering taken off the south of Rockall Bank, and again in one taken off the south-east end of the Island of Anticosti. This species, though generally distributed in the waters of the North Atlantic, North Sea, and Mediterranean, does not appear to have been recorded from any locality south of the Mediterranean. Its northern limit is Greenland.

Parapontella brevicornis was found only once, in the collection between the Isle of Man and Liverpool.

Acartia clausii occurred in nearly all the collections made between Liverpool and lat. 56° 8′ N., long. 38° 6′ W. In a few of the gatherings it was by far the most common species. Between lat. 56° 8′ N., long. 38° 6′ W., and lat. 49° N., long. 67° 45′ W., not a single specimen was observed, but in the collection made from the latter position to 90 miles from Quebec, it was again fairly common; this so far appears to be the western limit of its distribution.

Acartia longiremis is also apparently a widely distributed species, and was found in many of the collections.

Acartia laxa, easily distinguished from both the above species by the presence of spines on the posterior lateral angles of the cephalothorax, was taken in the Gulf of St. Lawrence, opposite the Island of Anticosti, but in no subsequent gathering. North of the latitude of the Cape Verde Islands this species has not been previously recorded, so that the present collection shows a considerable extension of its distribution. A fourth species of *Acartia*, found in the St. Lawrence, appears to be new, and is described below as *A. forcipata*, n. sp.

A species of *Corynura*, from the St. Lawrence, also appears to be new, and is described as *C. discaudata*, n. sp. It was also found in Puget Sound (see Appendix, p. 84).

Oithona spinifrons occurred in considerable numbers almost throughout the collections. All the specimens of *Oithona* observed have been ascribed to this species, although their mutilated condition rendered identification somewhat difficult. Clusters of ovisacs belonging to this species were found in many of the collections.

Oncœa conifera occurred sparingly in the collection made between Quebec and 30 miles west of Rimouski. The present record is a considerable extension of its limit of distribution.

Oncœa venusta also occurred sparingly in the collection made between lat. 56° 30′ N., long. 18° W., and lat. 56° 30′ N., long. 24° 22′ W., which is an extension of its limit of distribution in the North Atlantic.

Ectinosoma sarsii occurred in the last of the outward and first of the homeward collections made between Rimouski and Quebec. The species does not appear to have been previously recorded from the American coasts, so that the present collection shows a considerable extension of its distribution.

Ectinosoma atlanticum has a world-wide distribution; it occurred in several of the gatherings, but only sparingly.

Longipedia coronata was only observed in the collection made between Liverpool and the north of Ireland.

Thalestris serrulata occurred sparingly in three collections, those between Liverpool and the north of Ireland, in the Straits of Belle Isle, and between Rimouski and Anticosti. Out of British seas this species has not hitherto been recorded, so that the present collection shows a considerable extension of distribution of the species, which is apparently one of the pelagic Harpacticidæ.

Alteutha interrupta occurred sparingly in the collection made between Liverpool and the north of Ireland.

One specimen of an interesting parasitic species, *Nogagus borealis,* was found in one of the mid-Atlantic collections. It was first recorded by Steenstrup and Lütken in 1861, from a specimen found free swimming in the South Atlantic. Other members of the genus *Nogagus* are known to be parasitic upon sharks. This was the only parasitic form found in the collections.

The description of the three new species* is as follows:

Eurytemora herdmani, n. sp. (Pl. V., figs. 1—11.)

Length (exclusive of tail setæ), 1·6 mm. Body ovate anteriorly, the posterior angles being produced in the female into large conspicuous wing-like expansions (fig. 1).

Anterior antennæ (fig. 2) about as long as the cephalothorax; 24-jointed in the female, 21-jointed in the male right antenna (fig. 9). The proportional lengths of the joints in the female antennæ are as follows:—

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
36	10	8	8	8	6	7	5	6	5	5	8	13	14	15	16	17	18	18	18	16	16	19	26

Each joint bears one or more setæ on the upper surface. The 17th and 18th joints of the right male antenna (fig. 9) are finely denticulated on the upper edge; a geniculation being between the 18th and 19th joints. The apical joint is very small, the previous joints being much longer than any of the others. Posterior antenna (fig. 3) similar to that of *E. clausii,* with the exception of the setæ being non-plumose.

The mouth organs follow the general character of the Calaninæ. The mandibles (fig. 4) are large and powerful,

* See also description of a new species from Puget Sound in Appendix, p. 87.

the seven teeth being bifid, a curved claw-like spine forming the apex of a separate lobe. Basal portion of the palp large, the two setose branches being 2 and 4-jointed respectively.

The posterior foot jaws (fig. 5) are stouter than in most of the Calaninæ; the fine smaller terminal joints are densely setose. The second joint has four non-plumose setæ, and the basal joint three pairs of plumose setæ. Inner branch of 1st pair of swimming feet is 1-jointed, that of the 2nd, 3rd, and 4th 2-jointed (figs. 6 and 7). The 5th feet are jointed similarly to *E. affinis.* The penultimate joint in the female is much the longest, and is produced on the inner side downwards into a long spear-like spine extending beyond the spine of the terminal joint, and provided with short sharp teeth on each side (fig. 8).

The 5th feet of the male (fig. 10) are less robust than in *E. affinis*, the joints being more slender. The abdomen is 3-jointed in the female and 5 in the male (fig. 11); the first segment in the female has a conspicuous obtuse projection on each side posteriorly. Caudal stylets, long and narrow, with one lateral seta and four terminal setæ on each stylet, all finely plumose.

Males and females of this new species were found plentifully in association with *E. affinis* in the St. Lawrence, between Quebec and Rimouski. The penultimate joint of the abdomen in the female readily distinguishes it from the other species of the genus.

It is with peculiar pleasure that I. C. Thompson and A. Scott associate with this striking Copepod the name of Prof. Herdman, who collected the material upon which this paper is based.

Corynura discaudata, n. sp. (Pl.VI., figs. 1—11, Pl. VII., figs. 1, 2.)

Length (female, exclusive of tail setæ), 2·25 mm. Anterior antennæ long and slender, about the length of the entire animal, exclusive of the caudal segments (fig. 1); 18-jointed in the female (fig. 2), and 19 or 20 in the male, right (fig. 10), the former having six long setæ and several short spinous ones on the upper surface, and several long plumose setæ at the apex and shorter ones on the 1st and 2nd joints.

The right antenna (fig. 10) of the male is geniculated between the 14th and 15th joints, and is profusely clothed with short setæ on the upper surface, the apical setæ only being finely plumose. The proportional lengths of the joints in the female antennæ are as follows:—

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
12	21	8	21	10	12	12	14	15	19	19	20	18	16	16	17	21	13

Both branches of the posterior antennæ (fig. 3) are 2-jointed, those of the outer joint being of about equal length. The basal joint of the inner branch is very short, and the apical joint considerably larger than those of the outer branch.

The mouth organs are similar to those of *C. gracilis* with the exception of the mandible palp (fig. 4), the branches of which, in the present species, are respectively 2 and 3-jointed.

Both branches of the first pair of swimming feet (fig. 8) are 3-jointed; the inner branch of pairs 2, 3, and 4 (fig. 9) are 2-jointed, all bearing densely plumose setæ. Fifth pair in the female (Pl. VII., fig. 1) are simple, 2-jointed, similar to those of *C. gracilis*, but without any dentation at the apex. In the male (Pl. VII., fig. 2) the 5th pair is strongly hooked and prehensile.

Abdomen 3-jointed in the female and 5 in the male (fig.

11). The second joint of the male is drawn down posteriorly forming a blunt tooth with minute setæ at the apex.

The two last joints are slightly twisted laterally, the caudal segments, which are about three times as long as broad, being further curved round from the perpendicular. The right stylet is considerably larger than the left, and has on the outer side a strong prominent spine more than double the size of that on the other segment. Each segment bears five terminal plumose setæ.

The male is at once recognisable by the posteriorly produced tooth on the second joint of the abdomen and by the caudal stylets.

A number of specimens, both male and female, were taken in the nets on the 12th August, about the mouth of the St. Lawrence, near the Island of Anticosti, and the species was subsequently found plentifully in the plankton collected by Prof. Herdman in Puget Sound, on the Pacific Coast.

Acartia forcipata, n. sp. (Pl. VII., figs. 3—10.)

Length (exclusive of tail setæ), 2·35 mm. Body (fig. 3) similar in shape and appearance to the other members of the genus *Acartia*. Outer branch of posterior antennæ (fig. 4) 2-jointed; inner branch 3-jointed, the apical and penultimate joints being very short. Terminations of both joints bear a large number of long setæ; the basal joint of outer branch has seven spinous setæ on outer side. Mandible palp (fig. 5) has two short branches, 1- and 4-jointed respectively, both with long setæ, some of them plumose. Anterior foot jaw (fig. 6) 3-jointed, bearing numerous long uncinate and plumose setæ. Posterior foot jaw (fig. 7) composed of broad basal portion bearing long setæ, and a spinous 3-jointed branch.

Swimming feet, 1st to 4th pair (figs. 8 and 9) 2-jointed

on the inner branches, 3-jointed on the outer, the setæ of first foot (fig. 8) being non-plumose, the others (fig. 9) densely plumose, and having the characteristic *Acartia* spinal termination to outer branch.

The female 5th feet (fig. 10) of this species differ from the general character of the other known species of *Acartia* in being 2-jointed, whereas, in the other species, they are rudimentary. The stout basal joints bear a long plumose seta on each outer side. The terminal joints, which are about three times as long as broad, have a short central spine on the outer side, and a very long gracefully curved spine placed centrally on the inner side, also two short terminal spines.

Three specimen only of this evidently quite distinct species were taken in the St. Lawrence, about 100 miles from Quebec. The unfortunately mutilated condition of the anterior antennæ renders any accurate description of them impossible, but the 5th pair of swimming feet are sufficiently diagnostic of the species.

Conclusion.

By W. A. Herdman.

This method of collecting samples of the surface fauna, from an ocean liner going at full speed, in any required number and quantity per day or hour, was first practised, I believe, by Dr. John Murray, in a traverse of the Atlantic from Glasgow to New York in 1892, and afterwards in a trip through the Bay of Biscay, and the Mediterranean. From my experience I can entirely confirm the opinion expressed to me by Dr. Murray, that this plan of collecting is simple, effective, and inexpensive. It requires no complicated apparatus ; there is no difficulty in the manipulation, and no trouble to speak of need be given to any

of the ship's company. By this method naturalists can now obtain, at very slight expense, a series of gatherings across the great oceans in every direction traversed by passenger or cargo steamers. The ship's surgeon, or any other officer with a taste for natural history, or who is willing to take a very little trouble to help in advancing scientific enquiry into the life of the ocean can, by taking charge of a tow-net and a set of collecting bottles for a marine biologist, help in making an interesting series of observations which may lead to important conclusions.*

As Copepoda are edible, and can be obtained from the sea-water tap, the cook at sea has a new dish or, at the least, a sauce to add to the bill of fare, and all sailors ought to know, as was first pointed out by the Prince of Monaco, that they have a possible food supply, easily caught, in the sea around them. A tow-net should form part of the equipment of every ship's boat, ready for use in case of shipwreck; and every ship ought to carry a set of tow-nets, and collect material daily in order that the biologist may more accurately map out the exact distribution of organisms over the high seas, and determine the characteristics of the different oceanic currents throughout the year.

* If there are any such gentlemen sailing from the port of Liverpool, I hope they will place themselves in communication with me by calling at my laboratory in University College. I shall be glad at any time to supply the necessary nets and collecting bottles, and to give the simple instructions required.

APPENDIX:—NOTE on DREDGING and TOW-NETTING in PUGET SOUND, PACIFIC COAST.

By W. A. Herdman.

Between the dates occupied, as is shown above, in collecting on the Atlantic, I crossed North America by the Canadian Pacific Railway and spent nearly a week on the shores of Puget Sound, examining the shore and shallow water animals at various points:—notably, Victoria (British Columbia) and Port Townsend, in Washington State (U.S.A.). At Victoria I received much kindness, directions as to localities, and help in collecting from Dr. Crompton and other members of the Natural History Society. Mr. Fannin, the Curator of the Museum, also kindly gave me facilities for preserving and packing my specimens.

At Port Townsend, thanks to the kindness of my friend Dr. Bashford Dean, and Mr. B. B. Griffin, a member of the Columbia University Expedition to Alaska, who gave me the fullest information as to localities, and lent me their dredging apparatus, I was able to do a good deal of collecting in a short space of time. I hired a small steamer—the "Nettie B."—belonging to Capt. Hardie; and was engaged in tow-netting and dredging during parts of two days, Sept. 4th and 5th, off Port Townsend, and in Scow Bay and round Marrowstone Point opposite the port. The depths were up to about 20 fathoms.

At Victoria we had one day's dredging in a petroleum launch, at depths of from 5 to 15 fathoms, and one morning's collecting at low tide on the shore. I was fortunate at both localities in getting a good deal of material, which was preserved and brought home. The collection, now

in the Zoological Museum at University College, Liverpool, is not yet fully worked out; but the following brief remarks upon it may be of interest.

Off VICTORIA, B.C., we found:—

Various sponges.
Aglaophenia sp., and other Zoophytes.
Pennatula sp.
Actinians (several).
Cribrella leviuscula.
Asterias sp. (six rays).
Cucumaria (2 species).
Holothuria californica.
Echinids (2 species).
Annelids (various).
Sternaspis sp.
Polyzoa (various).
Terebratula sp.
Balanus (very large species, and two others).
Amphipods (various).
Idotea exsecata (large specimens).
Pagurids (several species, large).
Oregonia sp.
Pugettia sp.
Crabs (many, belonging to 4 genera).
Palæmon (various).
Hippolyte (several species).
Cryptochiton stelleri (very large).
Katharina tunicata (in abundance at low tide).

Also Mollusca belonging to the following genera:—*Leda* (2 species), *Pecten* (2 species), *Pandora*, *Cardium*, *Tellina*, *Pectunculus*, *Lyonsia*, *Fissurella*, *Puncturella*, *Patella*, *Calyptræa*, *Acmæa?* *Chiton*, *Bulla?* *Trochus*, *Buccinum*, *Turbinella*, *Murex* (2 species), *Crepidula*, *Natica*, *Neptunea*, *Tethys* (several specimens).

Ascidia sp.
Cynthia sp. (in great abundance).
Chelyosoma producta.
Molgula sp.
Compound Ascidians.

At PORT TOWNSEND we got:—

Zoophytes and Polyzoa (off Marrowstone Point).
Sponges (many, in Scow Bay).
Medusæ (small, also large Rhizostomidæ).
Actinians.
Holothuria californica (many, very large).
Annelida (various).
Amphipoda, Isopoda, and Macrura (many).
Pandalus danæ.
Crangon nigricauda.
Elysia sp. (on *Zostera*).
Eolis (large white species).
Tethys sp.
Cynthia sp. (in great profusion, evidently covering large areas of the sea bottom in Scow Bay.)
Ascidia sp.
Eggs of *Chimaera* and of a large Skate.

Mr. I. C. THOMPSON has examined for me the tow-nettings taken off Port Townsend, and he reports to me that they contain the following forms:—

Coscinodiscus radiatus (abundant).
C. concinnus (a few).
Ceratium fusus (abundant).
Pleurosigma sp. (scarce).
Other Diatoms (very many).
Chaetoceros sp.
Biddulphia sp.
Confervoid algæ.

Medusæ (many).
Evadne nordmanni.
Schizopods.
Oikopleura sp. (many).

Copepoda :—
Calanus finmarchicus (abundant).
Pseudocalanus elongatus (common).
Acartia clausii (scarce).
Corycæus pellucidus (abundant).
C. obtusus (common).
Oithona spinifrons (common).
Laophonte curticauda (few).
Anomalocera patersonii (few).
Diosaccus tenuicornis (scarce).
Pontella securifer (scarce).
Corynura discaudata, n. sp. (see above, p. 80).

And a new species of Copepod which seems to require a new genus, and which Mr. Thompson characterises as follows :—

Family SAPPHIRINIDÆ, Thorell.

Genus *Pseudolichomolgus*, n. gen.

Like *Lichomolgus* in general appearance; also in the antennæ, mandibles, maxillæ, anterior foot jaw, and fifth pair of swimming feet.

Conspicuous spinous rostrum.

Both branches of first four pairs of swimming feet 2-jointed.

Pseudolichomolgus columbiæ, n. sp. (Pl. VIII., figs. 1—10.)

MALE :—Length, 1·98 mm. Body elongated, cephalothorax ovate, its first segment occupying nearly half of its entire length. Rostrum (fig. 3) anchor shaped, composed of three strong spines, the two outer ones slightly curved outwards at end. The upper arched surface is

produced centrally into a rounded flap. Anterior antennæ (fig. 2) 7-jointed, their relative lengths being as follows:—

$$\frac{1 \quad 2 \quad 3 \quad 4 \quad 5 \quad 6 \quad 7}{12 \quad 12 \quad 4 \quad 11 \quad 10 \quad 9 \quad 9}$$

the first four being nearly double the width of the terminal joints. All bear short spines, a long one terminating the fourth and fifth joints, and three the apical joint.

Posterior antennæ (fig. 4) 5-jointed, the fourth joint very short. A sharp powerful curved claw with broad base forms the apex. Mandible (fig. 5) broad at the base with long slender finely setose stilet; no palp. Maxilla (fig. 6) consists of a broad base terminated by two spines.

Anterior foot jaw (fig. 7) of similar character to the mandible, with one finely plumose seta. Posterior foot jaw (fig. 8) consists of a single broad plate, its length half its breadth, and bearing a row of fine spines on its outer edge. Each branch of first four pairs of swimming feet (figs. 9 and 10) 2-jointed with strong spines and densely plumose setæ.

The first foot (fig. 9) is fringed with short setæ on the lower surface of basal joint. Fifth feet (fig. 1) 1-jointed, each having two terminal spines.

A single specimen of this singular species (sex, male) was taken by tow-net in Puget Sound.* Though bearing a strong resemblance to *Lichomolgus*, its remarkable rostrum and singular posterior foot jaw, as well as the 2-jointed swimming feet, completely separate it from that genus.

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* The specific name *columbiæ* refers to its occurrence in the strait between "Columbia" and British Columbia, and where, moreover, much good work has been done by zoological expeditions from the Columbia University, New York.

Some of the above-named animals from Puget Sound are common British species, and others are closely related or representative forms. I noted the presence of Starfishes very closely resembling our North Atlantic *Cribrella sanguinolenta*, *Stichaster roseus*, and *Solaster endeca;* while Mr. A. O. Walker, who is examining the higher crustacea, writes to me:—"The *Pandalus*, which is *P. danæ*, St., only differs from our common *P. montagui* in having one more tooth on the lower side of the rostrum, and two small teeth at its extremity instead of one; and *Crangon nigricauda*, St., is so very near our common Shrimp, that I do not think it ought to have been separated. Then there is a *Hippolyte* very like our *H. pusiola*, Kr., and another like our *H. spinus*, and so on. The *Idotea* is certainly *I. exsecata*, St., it represents our *I. linearis*."

This close resemblance between our common British species and some of the animals from this arm of the Pacific, a third of the way round the world, is most interesting. There are also, however, some very characteristic forms, such as the huge Holothurians and the magnificent Cryptochitons.

Explanation of Plates.

Plate V., *Eurytemora herdmani*, n. sp.

Fig. 1, female, dorsal view, × 35; fig. 2, anterior antenna, female, × 75; fig. 3, posterior antenna, × 95; fig. 4, mandible and palp, × 85; fig. 5, posterior foot jaw, × 125; fig. 6, foot of first pair, × 255; fig. 7, foot of fourth pair, × 255; fig. 8, foot of fifth pair, female, × 152; fig. 9, anterior antenna, male, × 75; fig. 10, fifth pair of feet, male, × 100; fig. 11, abdomen and caudal stylets, male, × 40.

PLATE VI., *Corynura discaudata*, n. sp.

Fig. 1, female, dorsal view, × 24; fig. 2, anterior antenna, female, × 35; fig. 3, posterior antenna, × 55; fig. 4, mandible and palp, × 35; fig. 5, maxilla, × 125; fig. 6, anterior foot jaw, × 55; fig. 7, posterior foot jaw, × 55; fig. 8, foot of first pair, × 85; fig. 9, foot of fourth pair, × 85; fig. 10, anterior antenna (right), male, × 40; figs. 11, abdomen and caudal stylets, male, × 40.

PLATE VII.

Figs. 1 and 2. *Corynura discaudata*, n. sp.

Fig. 1, fifth pair of feet, female, × 75; fig. 2, fifth pair of feet, male, × 75.

Figs. 3 to 10. *Acartia forcipata*, n. sp.

Fig. 3, female, dorsal view, × 25; fig. 4, posterior antenna, × 125; fig. 5, mandible and palp, × 50; fig. 6, anterior foot jaw, × 125; fig. 7, posterior foot jaw, × 75; fig. 8, foot of first pair, × 125; fig. 9, foot of fourth pair, × 125; fig. 10, fifth pair of feet, female, × 125.

PLATE VIII.

Pseudolichomolgus columbiæ, n. gen. and sp.

Fig. 1, female, dorsal view, × 18; fig. 2, anterior antenna, × 305; fig. 3, rostrum, × 255; fig. 4, posterior antenna, × 250; fig. 5, mandible, × 455; fig. 6, maxilla, × 500; fig. 7, anterior foot jaw, × 500; fig. 8, posterior foot jaw, × 380; fig. 9, foot of first pair, × 215; fig. 10, foot of fourth pair, × 215.

Printed and Issued December, 1897.

ELEVENTH ANNUAL REPORT of the LIVERPOOL MARINE BIOLOGY COMMITTEE and their BIOLOGICAL STATION at PORT ERIN.

By Professor W. A. HERDMAN, D.Sc., F.R.S.

[Read December 10th, 1897.]

THE past year, though comparatively uneventful, has been marked, as the following pages will show, by much solid biological work carried on at Port Erin and elsewhere on our littoral; and several of our local workers have opened up interesting lines of investigation of both scientific and economic importance. There was experimental fish hatching at Easter, several meetings have been held at Port Erin during the year and lectures and practical demonstrations given, the College tables have been well occupied, some additions have been made to our faunistic lists, and several notable papers published in scientific journals upon the results of work done at the Biological Station.

The fact that we have had fewer dredging expeditions than in some previous years is probably due to the absence of the Hon. Treasurer in Scotland and of the Hon. Director in America during a considerable part of the summer. But the new season will see renewed activity in this direction. Plans are being laid for a more detailed survey of our submarine area, for a systematic exploration of the problems of distribution and environment. The changes of the plankton, or floating life of the sea, a knowledge of which is so important in fishery questions, has already engaged our special attention, and, as will appear further on in this Report, a scheme is in operation for the simultan-

eous observation and record of the organisms on the surface at a number of stations in our district.

It is these general problems, sometimes extending over neighbouring sciences and requiring the co-operation of several specialists, which are now of the greatest interest and practical importance. Our specialists in marine biology are becoming more minute in the details of their work, but, at the same time, wider in their knowledge, in their outlook, and in the applications of their research. Biology—which has given not only to science but to all departments of knowledge the educational method of laboratory work and the great fundamental principle, Evolution, which underlies all advance—is ever ready to adopt methods and results from other sciences as an aid in the investigation of her special problems on land and sea. And in this age, pre-eminently that of Biology—the age of Darwin, Pasteur, and Lister—it is coming to be recognised equally over Europe and America that nowhere more than in Marine Biological Stations has the work of the great masters been followed up and extended, and that nowhere else can be found a more natural and happy union of the philosophy of science and of the industrial applications. It is that that gives to marine laboratories their first-rate importance both in pure science and in the work of Sea-Fisheries Committees, and which is causing universities all over the world to establish and maintain Biological Stations as a necessary condition for the advance of natural knowledge. Thus the University of Paris has Roscoff and Banyuls, Vienna has Trieste, St. Andrew's has just opened the Gatty Marine Laboratory, and Glasgow the Millport Station. We have our modest workshop at Port Erin, and our more extensive Fisheries Institution at Piel, in Lancashire, but we may well hope for and claim a larger and better equipped laboratory at

Port Erin, or at Hilbre, one more worthy of our University and of this great seaport. Liverpool owes much to the sea, it is asking but little that she should take her place in supporting oceanographic research.

Station Record.

The following naturalists have worked at the Port Erin Laboratory during the past year:—

DATE.	NAME.	WORK.
January.	Mr. I. C. Thompson, Liverpool	Collecting.
—	Prof. W. A. Herdman, Liverpool	
March.	Mr. H. Murray, Manchester	Algæ.
—	Prof. F. E. Weiss, Manchester	
—	Mr. I. C. Thompson, Liverpool	Copepoda.
—	Mr. F. W. Gamble, Manchester	Annelids.
—	Mr. Cole, Liverpool	Compound
April.	Prof. W. A. Herdman, Liverpool	Ascidians.
—	Mr. I. C. Thompson, Liverpool	Copepoda.
—	Mr. Cole, Liverpool	Ascidians.
—	Mr. H. Murray, Manchester	Algæ.
—	Prof. F. E. Weiss, Manchester	
—	Mr. F. W. Gamble, Manchester	Annelids.
—	Mr. J. H. Ashworth, Manchester ...	
—	Mr. Mundy, Manchester	General.
—	Mr. Claxton, Liverpool	General.
—	Mr. Wadsworth, Manchester	General.
—	Miss Hiles, Manchester	General.
—	Miss Pratt, Manchester	General.
—	Mr. Jameson, London	Turbellaria.
—	Mr. Jackson, Liverpool	General.
—	Mr. Gunn, Liverpool	Collecting.
—	Mr. A. Watson, Sheffield	Annelids.
—	Dr. Hurst, Dublin	Ascidians.
—	Mr. R. A. Dawson, Preston	Fish Hatching.
—	Mr. R. L. Ascroft, Lytham	
May.	Mr. F. W. Gamble, Manchester	Annelids.
June.	Mr. F. W. Gamble, Manchester	Annelids.
—	Mr. R. H. Yapp, St. John's Coll., Camb.	General.
—	Rev. T. S. Lea, Liverpool...	Photography.
July.	Rev. T. S. Lea, Liverpool...	Photography.

July.	Prof. W. A. Herdman, Liverpool ...	General.
—	Mr. I. C. Thompson, Liverpool	Copepoda.
—	Mr. Cole, Liverpool	Ascidians.
—	Mr. R. H. Yapp, Cambridge	General.
—	Mr. J. A. Clubb, Liverpool	Actinians.
—	Mr. Keeble, Manchester	Algæ.
—	Mr. Jackson, Liverpool	Arachnida.
August.	Mr. Keeble, Manchester	Algæ.
—	Mr. Jackson, Liverpool	Arachnida.
September.	Mr. Keeble, Manchester	Algæ.
—	Mr. I. C. Thompson, Liverpool	Copepoda.
October.	Mr. I. C. Thompson, Liverpool ...	Copepoda.
—	Prof. W. A. Herdman, Liverpool ...	Ascidians.
—	Prof. R. Boyce, Liverpool	General.
—	Dr. Warrington, Liverpool	General.
November.	Prof. W. A. Herdman, Liverpool	General.
—	Mr. I. C. Thompson, Liverpool	Copepoda.
—	Dr. R. T. Herdman, Edinburgh	General.
—	Mr. P. M. C. Kermode, Ramsey ...	General.
—	Mr. R. Okell, Douglas	General.
December.	Mr. H. C. Chadwick, Bootle	Collecting.
—	Prof. R. J. Harvey Gibson, Liverpool ...	General.

This is about the same total number as in the previous year. We have not this time the distinguished foreign Biologists who visited us after the British Association meeting in Liverpool; but our numbers of students and of ordinary workers are steadily increasing.

Amongst those in the above list are several students from Owens College, Manchester, and University College, Liverpool, who, along with members of the staff of the biological departments, have made use of the work places rented at the Station by the two Colleges. All of the students who took up Zoology as one of the subjects for their final B.Sc. examination in Victoria University, and of whom three passed with Honours, took advantage of the Port Erin Station during some part of their final year of study. During the year the Owens College table has been used by one professor, three demonstrators, two

junior assistants, and three students. The University College table has been used by one professor, two demonstrators, one assistant, one former assistant, and three students.

In addition to workers and students, we had many visitors, and on July 9th, the members of the Isle of Man Natural History Society spent a day at the Station. A public meeting of the Society and others was held in the Laboratory, and your Director gave them an Address upon "The Study of Marine Biology." On that occasion about thirty boys with some of the masters from King William's College, Castletown, also visited the Station, and took a lively interest in the Aquarium tanks and the specimens under microscopes.

Later in July Mr. T. S. Lea, who was working at the time at Port Erin, organised the visit of about thirty Liverpool Board School boys to the Biological Station, along with Mr. H. Edwards, one of their masters. They were taken for a zoological ramble round by Spanish Head and the Calf Sound, came back to Port Erin for tea, and afterwards examined the Aquarium tanks, and were taken to hunt the rock pools at low tide. Nothing is better calculated than marine biology—with its endless variations of form and colour, interesting habits, and instructive adaptations to environment and circumstance—to impress the youthful mind with a love of nature, to encourage powers of observation, to excite curiosity as to the causes of things, and to open up to those accustomed only to a town life some glimpses of the beautiful world of nature.

It has become evident to the Committee that, in the interests of the College students who are now attending the Biological Station, it is necessary to obtain a more highly qualified Curator than the Laboratory lad who has

looked after the place for the last couple of years. They feel also that the presence of a scientific man constantly at Port Erin will result in an improvement in the Aquarium and in the experimental fish hatching. The collecting and recording of specimens and physical observations which has depended so much in the past upon the chance visits of members of the Committee and other investigators ought, under a resident naturalist, to become systematised, and yield valuable results. The Committee consider they are fortunate in having been able to arrange with Mr. H. C. Chadwick—formerly of Owens College, and for some time Assistant Curator in the Bootle Museum—that he shall go into residence at Port Erin at the beginning of the new year, and shall devote his attention, in addition to the routine duties of the post, to a series of observations and investigations upon lines drawn up by the Committee.

It is becoming more evident year by year that both for the purposes of scientific Biology and also in the interests of fishery questions we must endeavour to gain a more intimate and detailed knowledge of the statistics of communities or assemblages of animals on the sea-floor, and of their habits and inter-relations.

A couple of years ago we published* some statistics of dredging on different grounds. This work should be continued and extended. Mr. A. O. Walker has lately† made comparison between the fauna on shallow and that on deep mud, in our area, with the result that the shallow mud shows by far the greater number of genera, species, and specimens of Crustacea. That is a valuable opinion, but refers to one group of organisms only. The individual members of our Committee are specialists—each with his

* Ninth Annual Report, p. 25, 1896.

† Liverpool Biological Society, November, 1897.

own absorbing interest—and though thoroughly alive to the importance of these general questions, they have rarely time or opportunity for sufficiently extended or continuous observations.

In this, as in other departments of work, we hope for much help from our new Curator. Regularity of investigation, observation, and record, and the accumulation of statistics as to modes of occurrence will soon give us a body of evidence from which to draw definite conclusions.

The Aquarium.

Over 350 persons paid for admission to the Aquarium during last summer. The Committee do not consider this a large number. The result of several years' experience is that when naturalists are at the Station—especially responsible members of the Committee — it is easy to attract numbers to a demonstration in the Aquarium. The visitors are interested and anxious to learn when there is anyone to show them what and how to observe, and to explain wherein the importance of the observation lies. In the absence of a scientific zoologist, the Aquarium has languished. Our new Curator will meet this want. He proposes to fill the shelves with collections of local animals, to re-stock the tanks and vessels, to lay out some microscopic preparations, and otherwise to make that part of the institution open to the public more attractive and more efficient.

The Boat.

The "Shellbend" folding dinghy, the acquisition of which was recorded in our last Report, has proved a very serviceable boat, and keeps in excellent condition. She holds three comfortably for tow-netting work about the bay, can be expanded for use or folded up again by one

person in about twelve seconds, and is light to carry up and down the shore. We are indebted to Mr. M. Treleaven Reade, of Liverpool, the inventor of the "Shellbend" patent, for the use of the accompanying cuts showing (fig. 1) the bottom of the boat when folded up, and (fig. 2) the interior when half expanded.

The Easter Party.

Notwithstanding rather boisterous weather the usual L.M.B.C. Easter Dredging Expedition was carried out with success, and the Port Erin Biological Station was never before so full of workers as it was during April. In the actual Easter week the rather limited accommodation was more than fully occupied, and the Committee are in hope that an extension may be provided, which will give several additional working places, before next Easter.

The Colleges of Liverpool and Manchester, it will be remembered, last year acquired the right to send members of their staff or science students to occupy certain work places for specified periods at the Port Erin Laboratory. On this occasion the Owens College was represented by Professor Weiss, Mr. F. W. Gamble, Mr. Ashworth, Mr. H. Murray, Mr. Wadsworth, Mr. Mundy, Miss Hiles, and Miss Pratt; University College, Liverpool, by Professor Herdman, Mr. F. J. Cole, Mr. Jackson, Mr. Claxton, and Mr. W. Gunn. Amongst other workers at the Station were—Mr. Arnold Watson (Sheffield), Mr. Isaac Thompson (Liverpool), Dr. Hurst (Dublin), and Mr. Lyster Jameson (Royal College of Science, London). The Lancashire Sea-Fisheries steamer "John Fell" (with Mr. Dawson, the Superintendent, and Mr. Ascroft, a member of the Fisheries Committee), was at Port Erin during the Easter week carrying on trawling investigations, and several general dredging expeditions were made with her. Spawn-

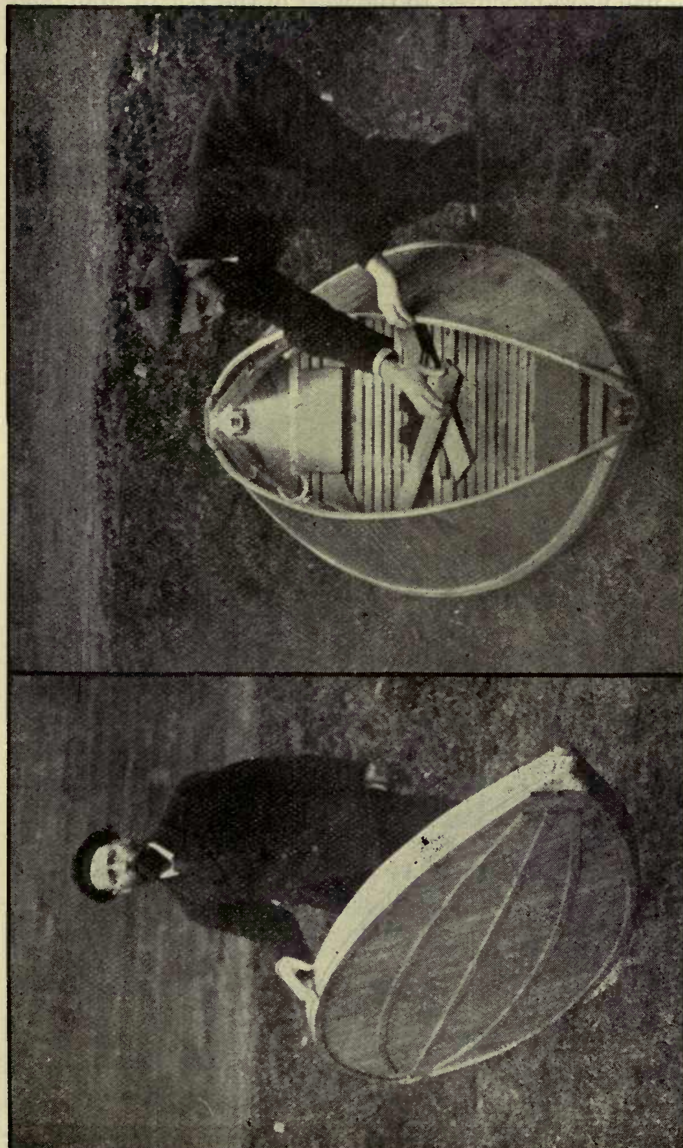


FIG. 1. 10 ft. Shellbend Dinghy. FIG. 2.

ing fish were procured to the west of the Isle of Man, and the tanks in the Biological Station were supplied with developing Lemon Soles and "Witches" (White Soles), and with a cross between the "Megrim" and the Cod. Elsewhere in this Report will be found the accounts given by several of the above-named naturalists of the work which they were engaged in at the Laboratory during the Easter vacation.

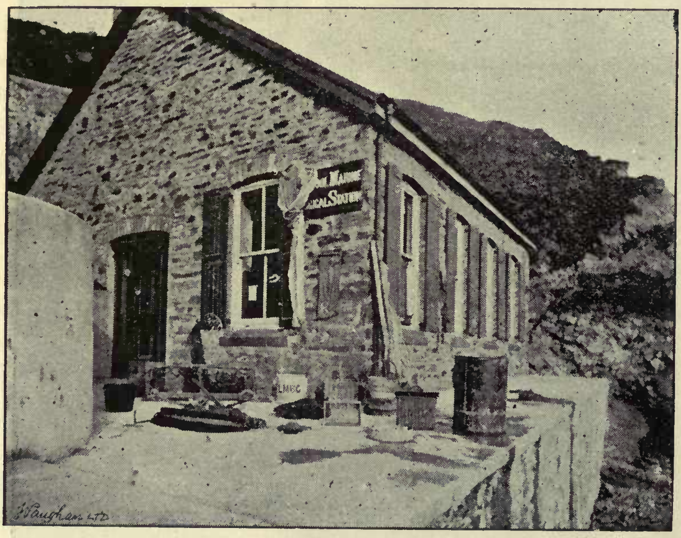


Fig. 3. Eastern half of the Port Erin Biological Station, from the steps, showing the apparatus—trawl, dredges, tow-nets, sieves, aquaria, pails, collecting jars and baskets—brought back from a dredging expedition.

Sea-Fish Hatching.

In continuation of the experiments carried out at Easter, 1896, last April the Lancashire Sea-Fisheries steamer, "John Fell," came to Port Erin under the direction of Mr. R. A. Dawson, the Superintendent, for the purpose of searching for spawning fish. On Saturday,

April 17th, we trawled mature fish of various kinds both flat and round, but did not succeed in getting both males and females of the same species in the ripe condition, and consequently no eggs were fertilized. On Monday, April 19th, we were more fortunate, and obtained to the north-west of Port Erin Lemon Soles and "Witches" spawning, and were able to fertilize the eggs. We also found spawning Megrims *(Arnoglossus laterna)*, and, as an experiment, we fertilized the eggs with the milt of a ripe Cod. As a result large numbers of the following embryos were started on their development in the Aquarium on the afternoon of the 19th :—

In tank I.—Lemon Soles *(Pleuronectes microcephalus)*.

In tank II.—"Witches" *(Pleuronectes cynoglossus)*.

In tank III.—Ova of Megrim fertilized by milt of Cod.

The arrangement of the hatching tanks, and the apparatus for the circulation of the water was described and illustrated in last year's Report.* The water during the hatching kept at a specific gravity of from ·26 to ·27 and at a temperature of from 46° to 47° Fahr. The cross between the Megrim (a flat fish) and the Cod only developed for from three to four days, and then all the embryos became abnormal and distorted, and died.

On April 26th the Witches began to move inside the egg covering, on the 27th the Lemon Soles were wriggling, and on the 28th both hatched out, eight and a half days after fertilisation of the eggs.

We have now shown conclusively that sea-fish hatching can be carried on readily at Port Erin, and beyond this experimental stage, dealing with only a few hundreds of eggs at a time, we cannot with our present accommodation and appliances pretend to go. If hatching on an industrial

* See Trans. Biol. Soc., vol XI., p. 67 and Pls. I—IV

scale is to be carried on at Port Erin, it will be necessary to erect a separate building—the hatching house—with an adjacent concreted pond and a boat jetty, alongside the Biological Station. The hatchery house, made two storeys high and placed in the gap to the west of our Aquarium, so that the lower floor would open on the beach and the upper floor from the Aquarium room, could be put up for a comparatively small sum by our local builder at Port Erin. The necessary concreted pond, to be used sometimes for spawning fish and sometimes for rearing young, could be readily made on the beach below, using the cliff as one side, while the opposite wall of the pond could be run out as a boat jetty. Such a hatchery would be available both for sea-fish eggs and also for hatching young lobsters, and its connection with the Biological Station should be an advantage to both institutions, and should especially conduce to the efficiency of the hatchery.

"Plankton" Observations.

From an early period in the L.M.B.C. work attention has been directed to the importance of careful observations on the periodic variations in the amount and nature of the plankton or assemblage of drifting organisms on or near the surface of the sea.

In 1888, during our first year of work at Puffin Island, we started our Curator of the Station taking weekly gatherings of surface organisms, which were sent to Liverpool and examined by Mr. Thompson. This was kept up intermittently during the five years of our occupation of the Puffin Island Station. During the first year of the Committee's work (1885) we noticed (see Report 1, p. 21, and Report 3, p. 8) in some of the gatherings the presence of those extraordinary numbers of *Halosphæra*, *Tetraspora*, and other minute gelatinous

Algæ which periodically cause, round our coast, what has been called "foul water." This was again noticed in 1886, and in subsequent years (Report 3, p. 8). In 1889 (Report 2) we noted the occasional occurrence of phenomenal numbers of *Anomalocera patersonii* over certain tracts of sea, and its subsequent complete disappearance. We also in that year made our first observations upon the effect of "baiting" the tow-net with an electric light, for use after dark both at the surface and at the bottom of the sea (for details see Report 2, p. 17). Further observations of this nature were made in 1889 (Report 3, p. 27), and in the same year's Report we published a summary of the observations throughout the year upon the temperature of the sea and the condition of the organisms upon its surface. A further observation of surface organisms in connection with "foul water" will be found in the next year's Report, for 1890. Other odd notes on the subject occur scattered throughout our ten previous Reports, and in Mr. Thompson's various papers reprinted in the volumes of the "Fauna" (see also "Fauna," vol. I., p. 324, for lists of surface organisms taken at Port Erin in the Summer of 1886).*

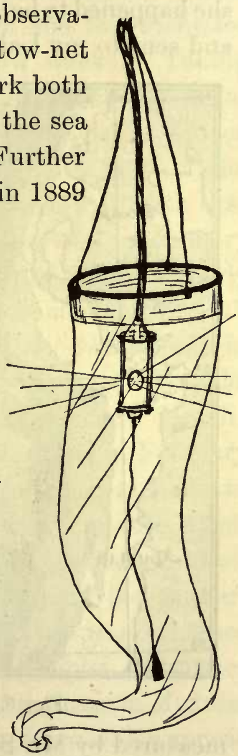


Fig. 4. Tow-net with electric light.

Last year we went a step further, and, with the help

* Prof. M'Intosh had carried out similar investigations for the Scottish Fishery Board in 1888 (see Seventh Ann. Rep. Fish. Bd., Scot., p. 259, 1889). More recently Messrs. Bourne, Bles, Garstang, and others at Plymouth have recorded the variations in the plankton at different times of the year.

of Mr. Andrew Scott, I organised a scheme for the weekly collection of surface plankton throughout 1897 at six stations in our district. The localities were Port Erin (I. of Man), New Brighton (near Liverpool), Lytham and mouth of Ribble (coast of Lancashire), Piel (Barrow Channel), and from the Fisheries steamer, at sea, wherever she happened to be. The collections were taken, preserved, and sent to my Laboratory at Liverpool, where they were

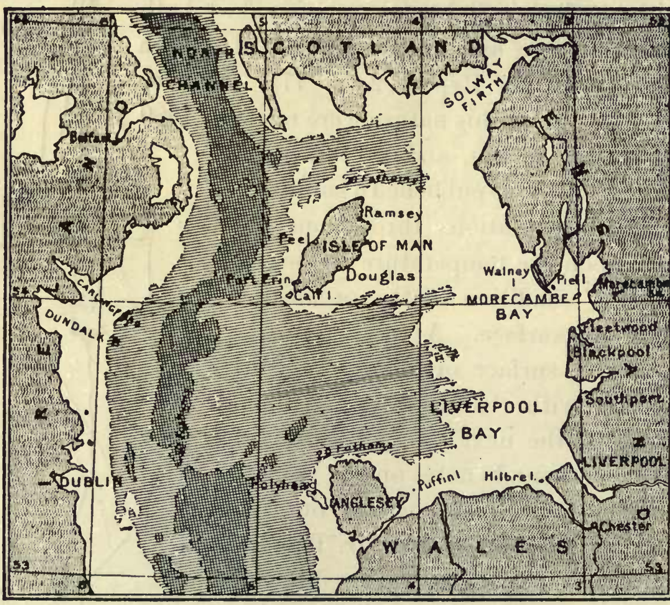


Fig. 5. Plan of the L.M.B.C. District.

measured by Mr. Scott and then examined in detail. The scheme was started towards the end of January, and was kept up as regularly as possible—perfect regularity is not possible, first, on account of the weather, and secondly, because the bailiffs who take the gatherings are liable to be called off occasionally to other duties. During the first fourteen weeks the number of gatherings received

out of the possible six were—5, 6, 4, 3, 4, 2, 3, 4, 4, 3, 3, 5, 3, 4.

These gatherings, which have been worked up fully, bring the record up to the end of April. The rest of the collection, which is now in process of being examined, consists of some sixty tubes, giving an average of nearly two a week for the remainder of the year. The results will be given in the Report on the work of the Sea-Fisheries Laboratory, to be published in a few weeks. Taking these statistics, along with the many previous less complete records that we have, extending back for ten or twelve years, there are some prominent features of the collections taken week by week and month by month that arrest attention—the abundance of *Sagitta* in January and February; the comparative scarcity of Copepoda early in the year; the abundance of diatoms, such as *Biddulphia*, *Coscinodiscus*, *Rhizosolenia*, and *Chætoceros*, in February and early spring; the appearance of Nauplei and then other larval forms in February and March; the comparative scarcity of plankton all round in February and March (except when gelatinous Algæ sometimes swarm in the latter month, and even later); the increase in April, and especially the increased abundance of pelagic Coelenterates and of Copepoda in early summer; the appearance of fish eggs and embryos and larval fish in abundance about Easter; the disappearance of Nauplei and other larvæ as summer goes on, and the great increase in Medusæ and Ctenophora; the quantities of *Oikopleura* which appear in the height of the summer; the abundance of Dinoflagellates in late summer and autumn; the great relative abundance of life in general during July, August, and September, and finally the rapid diminution in the amount and variety of plankton during the last few months of the year.

There are, on the other hand, some organisms, such as the Algæ *Halosphæra* and *Tetraspora*, the Infusorian *Noctiluca*, and the Copepod *Anomalocera*, which seem to vary greatly in their abundance from year to year; but probably when we have a more complete knowledge of the plankton of the North Atlantic, and of the relations existing between physical conditions and the distribution of organisms, we shall be able to assign rational causes for these curious irregularities in the floating population of our seas.

We have arranged that in 1898 gatherings will be taken weekly at the same six stations, but rather further out at sea, so as to avoid the disturbing influence of the shore.

It is interesting, in this connection, to note that of all the tow-net gatherings which I took this summer in crossing the Atlantic twice, between Liverpool and Quebec, once at the beginning of August, and again at the end of September, those from the sea around Port Erin, between Liverpool bar and the north of Ireland, were the richest in species. The following are the lists of organisms observed in the gatherings in question, quoted from the paper recently published by Herdman, Thompson, and Scott* :—

[Outward Journey—Liverpool to Quebec.]

"**1.** August 5th, 9 p.m., to August 6th, 8 a.m. From 50 miles off Liverpool to about Rathlin Island, Ireland. Water slightly phosphorescent; no *Ceratium* observed; an ordinary Irish sea gathering, containing:—Fish eggs, Gastropod larvæ, *Limacina retroversa*, *Nyctiphanes norvegica* (small), Nauplei, and Zoeas (Crab), Amphipoda (fragments), *Philomedes interpuncta*, *Sagitta bipunctata*, *Mitraria* larva, Medusoids (small), Campanularians

* Trans. L'pool. Biol. Soc., vol. XII., p. 33.

(broken), *Oithona spinifrons* (common), *Calanus finmarchicus* (common), *Paracalanus parvus* (few), *Temora longicornis* (few), *Acartia clausii* (few), *Metridia armata* (rare), *Pseudocalanus elongatus* (few), *Centropages hamatus* (few), *C. typicus* (few), *Anomalocera patersonii* (few), *Longipedia coronata* (rare), *Ectinosoma atlanticum* (rare), *Thalestris serrulata* (rare), *Alteutha interrupta* (rare)."

[RETURN JOURNEY—QUEBEC TO LIVERPOOL.]

"**P**, on bath tap, October 3rd, 5 p.m., to October 4th, 10 a.m. (off Port Erin). *Ceratium tripos*, *C. fusus*, *Peridinium divergens*, *Dictyocysta elegans*, Diatoms, *Globigerina bulloides*, *Calanus finmarchicus* (common), *Centropages hamatus* (few), *Metridia armata* (few), *Pseudocalanus elongatus* (common), *Oithona spinifrons* (few), *Acartia longiremis* (few), *Isias clavipes* (scarce).

"**XXI.** and **XXII.** October 3rd, 7 p.m., to October 4th, 9 a.m.; from 20 miles north of Tory Island to 15 miles west of Peel. Great deal of material. Part of it probably from entrance to Lough Foyle, where we stopped for an hour at midnight. Nets at overflow pipe had Sagitta, Medusæ, Amphipoda, and the larger Copepoda; nets at tap had much finer stuff—the Protozoa and the smaller Copepoda. *Ceratium tripos* (few), *C. fusus* (few), *Navicula* sp., *Dictyocysta elegans*, *Globigerina bulloides*, Unicellular Algæ, Medusæ (small), *Sagitta* sp. (abundant), Megalopa, *Gastrosaccus spinifer*, *Hyperia galba*, *Euthemisto compressa* (common), *Calanus finmarchicus* (common), *Acartia longiremis* (common), *Metridia armata* (common), *Pseudocalanus elongatus* (common), *Centropages hamatus* (few), *C. typicus* (few), *Anomalocera patersonii* (few).

"**XXIII.** October 4th, 9 a.m. to 2 p.m.; from 15 miles west of Peel to near Liverpool Bar. Nets at overflow pipe. *Sagitta bipunctata* (abundant), *Ceratium tripos*

(common), *C. fusus* (common), and *C. furca* (common), *Dictyocha speculum*, *Coscinodiscus radiatus* (common), *Globigerina bulloides* (common), *Biddulphia* sp. (common), *Calanus finmarchicus* (common), *Acartia longiremis* (abundant), *Metridia armata* (few), *Pseudocalanus elongatus* (abundant), *Centropages hamatus* (few), *Isias clavipes* (common), *Parapontella brevicornis* (few), *Labidocera wollastoni* (common).

"**XXIV.** October 4th, same time and locality as **XXIII.** Nets at tap (fine stuff). *Ceratium tripos* (abundant), *C. furca*, and *C. fusus*, *Coscinodiscus radiatus*, *Peridinium divergens*, *Dictyocha speculum*, *Tintinnus acuminatus*, *Codonella campanula*, *Halosphœra viridis*, *Rotalia beccarii*, *Calanus finmarchicus* (common), *Acartia longiremis* (common), *Metridia armata* (few), *Pseudocalanus elongatus* (few), *Temora longicornis* (few), *Centropages typicus* (few), *Labidocera wollastoni* (common), *Oithona spinifrons* (common)."

Faunistic and Other Special Investigations.

During the year a good deal of collecting has been done on the shores of the south end of the Isle of Man, and the Laboratory Assistant has made many gatherings of Copepoda from the sand and mud at low tide, and has sent them to Mr. Thompson. The tow-net has also occasionally been attached to the buoy at the entrance to Port Erin bay, and left out all night. One such gathering taken in November was sent to Mr. A. O. Walker, and he reports to me that it contained :—

Siriella armata (M. Edw.), several young.
Cuma scorpioides (Mont.), one only.
Iphinoe trispinosa (Goodsir), one only.
Bathyporeia pelagica, Bate, one only.
Apherusa bispinosa (Bate).

Atylus swammerdamii, M. Edw.

Dexamine spinosa (Mont.).

Mr. I. C. Thompson reports as follows in regard to Copepoda :—

"During the 'John Fell' expedition of April 19th, a quantity of fish were trawled. A search for fish parasites led to two additions to the L.M.B.C. fauna, viz.: *Trebius caudatus*, Kroyer, and *Caligus diaphanus*, Müller, of which the former were taken in numbers, both males and females, from the Hake, and of the latter a few specimens were found on the Cod.

"On a specimen of *Calanus finmarchicus*, I found the small parasitic Isopod *Microniscus calani*, belonging to the Epicarideæ. Although not infrequently met with on Calani taken in more northern regions where the latter are found in profusion, it appears not to be common about our shores, and has hitherto escaped record in our district.

"W. Bridson, the Laboratory boy, has occasionally, by means of the very convenient "Shellbend" boat, fixed a tow-net to the buoy, near the breakwater, where it has remained all night. Although no forms of Copepoda new to the district have hitherto been met with through this method, the results in material have been such as to warrant our continuing it when practicable throughout the coming year.

"Washings of mud and sand taken at low water from various parts of Port Erin bay, have resulted in our obtaining a large variety of sedentary Copepoda, and among them Mr. A. Scott has recently found some very minute Harpacticidæ of one or more species new to science, but which we are not yet prepared to describe. Some of the rarer sedentary species are occasionally found by this means in very large numbers, as was the case in

October last, when some mud taken near the breakwater was found to swarm with *Laophonte lamellifera*. The rocky pools about Port St. Mary, too, have yielded good results."

Dr. George W. Chaster, of Southport, who has undertaken to report upon the FORAMINIFERA of the district, writes to me:—

"There is one aspect of the work in this group I should like to enter upon. Foraminifera are so enormously abundant, and multiply so rapidly, that they must afford an important food supply to some other animals. I only know of one group of Mollusca—the Scaphopoda—which subsist solely, or almost so, on Foraminifera. There must be many other consumers, and I propose to examine stomachs of various other animals that seem likely. I shall be pleased to examine consignments of stomach-contents which have a gritty feel, if sent to me, with full data. Fish stomachs should yield good results. The reproduction of Foraminifera is also a matter requiring further investigation."

Professors Boyce and Herdman still continue their work on the bacteriology and other diseased conditions of Oysters. In the report of the "Oyster" Committee to the British Association Meeting at Toronto last September, it was shown that there are considerable quantities of copper in certain green leucocytes found in a diseased condition of the American Oyster. The Oysters in this state are always more or less green, and the colour is due to the presence of a compound of copper. The amount of copper is far in excess of what can be accounted for as due to hæmocyanin, and it may be explained as due to a disturbed metabolism, whereby the normal copper of the body becomes stored up in certain cells. The *cause* of this diseased condition is still undetermined.

Mr. F. W. Gamble and Mr. J. H. Ashworth, of Owens College, Manchester, spent three weeks of the Easter vacation, 1897, at the Port Erin Biological Station, working at the anatomy of the species of *Arenicola*, and Mr. Gamble again visited the Station for a few days at Whitsuntide for further research into the same subject. The following is a summary of the results obtained :—

"The shores of Port Erin and Port St. Mary are inhabited by three well-marked species of *Arenicola*, *A. marina*, *A. ecaudata*, and *A. grubii*. The best known of these, *A. marina*, the common 'lug-worm,' is represented on the coarse sandy beaches by the small littoral variety characterised best by the delicate gill plumes being each composed of four or five lateral branches on either side of the main vascular axis, and by constructing U-shaped galleries in the sand. In the gravel and amongst the debris of decomposing rock on the shore of Bay-ny-Carrickey a large, dark variety occurs with gills of the same type, but strongly pigmented. The blood-vessels are very large and turgid. This variety, which may attain a length of one foot, is distinguished by the form of its gills from a somewhat similar, dark, bulky variety, occurring at extreme low water on the Lancashire coast (and known to the fishermen as 'worms,' in contradistinction to the littoral form or 'lugs'), in which the gills have ten or eleven lateral branchlets, and hence a pinnate form. This 'Laminarian' variety has not hitherto been found at Port Erin, but this is probably due to the great depth (up to four feet) to which it is known to burrow.

"The two species *A. grubii* and *A. ecaudata* belong to a division of the genus characterised by the continuation of the gills and parapodia to the hinder end of the body. They are distinguished from one another by important

anatomical peculiarities, which have hitherto escaped notice, with the result that no record of *A. ecaudata*, on British shores, excepting only that made by Dr. G. Johnson, can be accepted as trustworthy. Even the record in the Tenth Annual Report of the L.M.B.C., p. 26, should be *A. grubii*, and not *A. ecaudata*, as printed.

"To establish the differences between these two forms was the chief result obtained by Messrs. Gamble and Ashworth. They have found that *A. ecaudata* has the first gill implanted immediately behind the 16th notopodium on each side, whereas, in *A. grubii*, the first pair of gills occurs behind the 12th notopodia; that the nephridia open on segments 5—17 inclusive, in *A. ecaudata*, while in *A. grubii* there are only five pairs of these organs opening on segments 5—9; that, in the former species, the gonads are massive and compact; in the latter, diffuse and floating freely during maturation.

"The anatomy of Johnston's *A. ecaudata* has hitherto remained unknown. Our researches have shewn it to be by far the most interesting member of the genus, in that it possesses *thirteen* pairs of nephridia, the first of which opens on the 5th chætigerous segment, and the last on the 17th, or the second of the gill-bearing segments. Hitherto it has been supposed that the six pairs of nephridia of *A. marina* were typical for the genus both in number and in form. It now appears, however, that the nephridia of the true lug-worms are reduced in number, as compared with the similar organs found in *A. ecaudata*, and that the relation of these nephridia to the gonads, is of a more intimate and less transient character than is usually supposed to be the case, and though different in detail, is essentially similar in plan, in these two species. The characters by which *A. ecaudata* may be recognised are—the presence of the first pair of gills

on the 16th chætigerous segment, and of well-marked notopodia on the first segment. The corresponding neuropodia are not closely approximated in the mid-dorsal line.

"The third species of *Arenicola* found in the district occurred along with *A. ecaudata* in fine gravel on the south side of Bay-ny-Carrickey, and also, though not so abundantly, on the south side of Port Erin bay. It is certainly the *A. grubii* of Claparède, which has been hitherto described from Naples, and agrees with his description (incomplete though this is) in all essentials as in the number and position of the gills, the number (five pairs) and relations of the nephridia, and the form of the chætæ.

"In our specimens, the first pair of notopodia are absent or extremely reduced, so as to be very rarely visible externally, while the corresponding neuropodia are continued upwards and inwards, so that they almost meet in the median dorsal line. The first pair of gills is attached to the 12th chætigerous segment. Of the five pairs of nephridia, the first opens on the 5th segment (as in *A. ecaudata*), and corresponds in position with the 2nd nephridium of *A. marina*. In addition to these observations (which introduce *A. grubii*, hitherto only known from the Mediterranean, into the British Fauna), some further work was done upon the anatomy of *A. marina*, and the result of this investigation will appear shortly in the 'Quarterly Journal of Microscopical Science.'

"Of these three species, *A. marina* contained little or no traces of reproductive organs. Ripe females of *A. ecaudata* and of *A. grubii* were abundant, though males were scarce and immature (March 26th to April 16th, and the same appeared to hold good at Whitsuntide). It appears that the shore lugs are ripe in the middle of

summer, specimens from Port Erin examined last August proving to be as completely so as the large 'Laminarian worms' were at Blackpool from the end of January to the middle of May. Meanwhile, Mr. Gamble would be very greatly obliged if his fellow workers, during the coming spring, could send to Owens College, Manchester, any specimens of what are suspected to be larvæ or post-larval stages of the common lug-worm, the eggs and development of which are still quite unknown."

Amongst the workers at the Biological Station at Easter was Dr. C. H. Hurst, of Dublin. Dr. Hurst kindly offered to do some work for me, so I suggested that he should make a series of observations and experiments in regard to the currents of water entering and leaving the two apertures of *Polycarpa glomerata*, a gregarious red-coloured simple Ascidian found in great abundance under the limestone masses at Perwick Bay, and clothing the sides of the caves at the sugar-loaf rock. Dr. Hurst has sent me the following account of his results along with some diagrams and an exact record of all his experiments:—

"At the request of Prof. Herdman, I made some simple experiments at the Port Erin Laboratory of the Liverpool Biological Committee, at Easter, 1897, with the object of discovering whether or not the direction of flow into and out of the branchial and atrial cavities of Polycarpa was constant.

"To test the direction of the currents, the water in the immediate neighbourhood of the branchial and atrial apertures was made streaky by causing small vortex rings of water-colour paint (lamp black) to pass close to these apertures. This was easily effected by means of a small glass cannula with an india-rubber cap. To eliminate the effect of gravitation, the paint was mixed in the first

instance with sea-water, and fresh-water was then added drop by drop till the specific gravity, as tested by the behaviour of small vortex rings, was identical with that of the sea-water in which the Polycarpæ were living.

"Results:—(1) At the moment of contraction of the body water was driven violently out by the branchial and less violently out by the atrial aperture.

"(2) When undisturbed a slow steady current enters by the branchial aperture.

"(3) When undisturbed the current at the atrial aperture is slow, and is sometimes inwards and sometimes outwards. It was observed to flow thus in opposite directions, while the inward current at the branchial aperture remained constant and steady.

"(4) When a moderately strong mixture of the paint was used, the entrance of it by either aperture was followed (sometimes immediately, but at other times only after a considerable quantity had been inhaled) by sudden contraction of the body and expulsion of water by both apertures, but chiefly by the branchial. In some individuals, at least, this contraction followed more rapidly upon entrance of the paint by the atrial aperture than by the branchial.

"These results would seem to verify the suggestion of Prof. Herdman* that the occurrence of tentacles about the atrial aperture is connected with an occasional inhalation by that aperture, the tentacles serving to detect impurities in the water so inhaled, the stimulation being followed by contraction of the body and expulsion of the impure water."

* British Association Report, Edinburgh, 1892, p. 788; and Bulletin Scientifique de la France et de la Belgique, t. xxv., p. 56, 1893.

Mr. Arnold Watson, of Sheffield, sends me the following report upon his work:—

"My object in going to the Port Erin Biological Station in April last was chiefly to obtain fresh material for studying the spinning gland of *Panthalis oerstedi*, and so far as the dredging operations were concerned, the object was attained, since we captured the only complete specimen we have ever got, our previous captures being (with the exception of a very young one, which lived in my tank a year) fragments, chiefly the anterior portions, though once a posterior part was taken. The complete specimen above-mentioned was 3¼ inches long when at rest. When moving it would be rather longer. I was unable to get it to settle in my tank, though I provided it with mud, &c., and at the end of ten days I killed it, as it was evidently ailing. This specimen was lent to Prof. M'Intosh, who desired to make a drawing from it for his forthcoming Monograph on British Annelids, and he has since returned it.

"We also got an anterior portion of another *Panthalis*, which lived in my tank until the end of June. It had commenced renewing its hinder quarters, in fact had grown two small anal cirri, when I found it necessary to kill and preserve it. We got a considerable number of mud tubes belonging to *Panthalis*, nearly all of which were empty.

"I am sorry to say that ill-health has prevented my making use of the material in the way I intended, and so far I have no further progress to report, though I hope in the near future to again take up the study of the spinning gland, and give a further description of *Panthalis* and its mode of working.

"I think there are only the following two additions to make to your list of species. They are worms which were

dredged up with *Panthalis*, from deep water between Port Erin and Ireland:—*Glycera alba* (Rathke), and *Praxilla gracilis* (Sars). We have previously got them from the *Panthalis* ground, but have not recorded them.

"I got a very fine specimen of *Owenia filiformis* from low water mark opposite Port Erin. I notice that Hornell has not recorded it as found at the Isle of Man, though I was under the impression we have got it by dredging off Bradda Head. I also got *Magelona papillicornis* from low water mark at Port Erin. It also is not recorded in Hornell's list, except in the Lancashire and Cheshire column. So these are additions to the Manx fauna.

"You will be glad to hear that my observations of *Owenia* have been very successful. I have induced the beast to show me his building operations, and by means of experiments, have ascertained how the imbrication of the sand on the tubes is produced. The animal has been good enough to exhibit the action of the labial organ (metastomium), and I have seen it licking the grains of sand, building with them (for which purpose it selects the flat ones), and burrowing or digging down into the sand. That organ is not used for burrowing upwards. The surface of the sand in which the worm lives is reached by a peculiar screwing and undulatory motion of the worm inside its tube. The latter, held by the innumerable uncini, travels with the worm inside it, and is made to stretch until the surface of the sand is reached, though, very occasionally, the hinder part of the tube breaks off (I have only seen this happen once out of a considerable number of trials). It is very much easier for the worm to work its way to the surface than to go down into the sand (if by chance stranded), although, in the first case, the sand on the tube is so arranged as to

cause much more friction, *i.e.*, all the edges of the flat particles are exposed to the sand, but they will, I suppose, act to some extent like the cutting edge of a drill. In going down the worm and tube seem always to travel the other way, so there is less friction, but evidently much more work. I have not yet quite finished my observations."

Professor Weiss and his Museum Assistant, Mr. H. Murray, collected Algæ at Port Erin during the Easter vacation. Prof. Weiss gives me the following list of species which have not previously been recorded, and are, therefore, new to the locality :—

Dermocarpa prasina, Born. On *Catenella opuntia* and *Laurencia pinnatifida*.

Spirulina tenuissima, Kütz. Sparingly amongst *Rhizoclonium riparium*.

Rivularia atra, Roth. In shallow pools of fresh water, near high water line, which would be over-run by the sea at high tide.

Rhizoclonium riparium, Harv.

Urospora speciosa, Holm. et Batt.

Enteromorpha ramulosa, Hook.

Ralfsia verrucosa, Aresch.

Callophyllis laciniata, Kütz.

Melobesia corallinæ.

Lithothamnion colliculosum, f. rosea, Fosl. Pt. St. Mary.

Mr. F. W. Keeble, Assistant Lecturer in Botany in the Owens College, Manchester, occupied the Owens College work table during the summer vacation, and was engaged in work on some physiological problems in the nutrition of red sea-weeds. Mr. Keeble reports as follows :—

"During my stay of about two months at Port Erin I was engaged in investigating the significance of the red pigment of the Floridiæ. The research, although incomplete,

seems to point to several interesting conclusions as to the nature of the so-called Floridean starch, the destruction of the red pigment, and the starch-depletion of the cells in intense sunlight. Cases of apparent etiolation-phenomena among the red sea-weeds were recorded, and stages in germination of their spores under various conditions observed."

Prof. Herdman and Mr. F. J. Cole have commenced an investigation on the process of budding and the formation of colonies in various genera of the Compound Ascidians in the hope of being able to throw some light upon the curiously contradictory accounts which have been given by different writers (such as Pizon, Caullery, Ritter, Hjort, and others) of late years, and some of which, if established, would have an important influence on our views as to certain current biological theories. It is also proposed to include in the investigation the comparison and correlation (if any correlation is possible) of the development of the bud with the development of the embryo. Large numbers of colonies have now been collected, preserved, and sectioned at different times of the year from last April onwards. The state of affairs in *Botrylloides rubrum*, and in a species of *Amaroucium*, of which the most complete series have been obtained, will be investigated first.

So far as these observations have yet gone, the process seems to be in agreement with that described by Ritter, and by Lefevre in his recent paper, which has appeared since the present investigation commenced.

Mr. H. Lyster Jameson, B.A., from Dublin, spent two weeks in April at the Laboratory, in work on the TURBELLARIA in continuation of the researches of Mr. F. W. Gamble on that group in a former year. Mr. Jameson gives me the following summary of his results so far:—

"The species recorded are the following, those new to the district being marked with an asterisk(*):—

"**Polycelis nigra* (O.F.M.) [in fresh-water]; *Aphanastoma diversicolor*, Oe.; *Convoluta paradoxa*, Oe.; *Promesostoma marmoratum* (Schultze); *P. solea* (O. Schm.); **P. agile* (Levinsen); *Byrsophlebs intermedia*, v. Grff.; *Proxenetes flabellifer*, Jensen; **Mesostoma neapolitana*, v. Gr.; *Pseudorhynchus bifidus* (M'Intosh); *Acrorhynchus caledonicus*, Claparéde; *Macrorhynchus nägelii* (Köll.); **M. croceus*, Fab.; *M. heligolandicus*, Metschnikoff; *Provortex balticus* (Schultz); **P. affinis* (Jensen); *Fecampia erythrocephala*, Giard; **Graffilla buccinicola*, n. sp.; **Plagiostoma koreni*, Jensen; *P. vittatum*, Frey and Leuck.; *Vorticeros auriculatum* (O.F.M.); *Cylindrostoma quadrioculatum* (Leuck.); *Monotus fuscus*, Oe.; *M. lineatus* (O.F.M.); *Stylochoplana maculata* (Quatref.); *Leptoplana tremellaris*, O.F.M.; *Cycloporus papillosus*, Lang, var. *lævigatus*, Lang.

"The occurrence of *Mesostoma neapolitana* is of interest, it has hitherto only been found at Plymouth and at Naples. Only the cocoons of *Fecampia erythrocephala* were found. I have since found this worm in more than one locality on the Irish Coast.

"Besides identifying these species I have commented in my report upon certain anatomical characters in various of them, and have recorded one or two interesting varieties. I have also endeavoured to determine the relative abundance of the different species that came under my notice.

"I also describe a new species, which I refer to the genus *Graffilla*, v. Jhering, under the name of *Graffilla buccinicola*. It was found in the kidney of *Buccinum undatum* and *Fusus antiquus*. This species differs from the other members of the genus in the form of the body,

in the form and relations of the gonads, in the position of the reproductive aperture, and in the possession of pigment spots in the superficial parts of the body parenchyma. It comes nearer to *G. muricicola* than to either *G. tethydicola*, v. Graff, or *G. brauni*, Ferdinand Schmidt. *G. mytili* (Levinson) has been described in such a way that its position in the genus cannot be determined until the species is rediscovered. The genus *Graffilla* is a new record for British seas."

Mr. J. A. Clubb, M.Sc. (Vict.), and the Rev. T. S. Lea, M.A., were both at work in different ways on Sea-Anemones during a part of the summer. Mr. Clubb is investigating the animals from an anatomical and histological point of view, dealing with variations in the mesenteries, and studying the structure of the species according to the lines laid down by Prof. Haddon; while Mr. Lea is observing the habits and photographing different conditions and positions—feeding them under the eye of the camera, and taking pictures of them at home in their rock-pools. We shall probably have papers from both these workers, giving their results, at the Biological Society during the winter.

Mr. A. Randall Jackson, B.Sc. (Vict.), spent the Easter vacation at Port Erin, and occupied the University College table in the Laboratory. Besides taking part in the dredging expeditions, in tow-netting on the bay, in general out-door zoology, and in preparing for his Victoria University Examination—which he afterwards passed with first-class Honours—Mr. Jackson commenced to collect and to study the spiders of the neighbourhood. After taking his degree, Mr. Jackson returned to Port Erin for part of the summer vacation, and continued to collect and work out the spiders. He has already identified about forty species of the group, and he proposes to return to the

Laboratory next year and complete a "Report upon the Araneida of the District."

The remarkable new green Gephyrean worm referred to at p. 24 of last year's Report, has since been fully described, discussed, and illustrated, in a recent part of the "Quarterly Journal of Microscopical Science,"* under the name of *Thalassema Lankesteri.* It is in some respects intermediate in its characters between *Hamingia arctica* from Norwegian seas and *Thalassema gigas* from Trieste. It might have been described as a new genus lying between *Hamingia* and *Thalassema*, and forming a term in the series—*Echiurus, Thalassema*, the Port Erin form, *Hamingia, Bonellia;* but I preferred to enlarge rather the genus *Thalassema* for its reception. The remarkable green colour (which I have called "Thalassemin") has been discussed by Prof. Lankester in a paper in the same number of the Quarterly Journal, and has been contrasted with "Chætopterin," "Bonellin," and some other green tegumentary pigments.

In connection with this new British worm *(Thalassema Lankesteri)*, Mr. Lyster Jameson writes to me:—"I have found in the Dublin Museum Collection a specimen of the *T. gigas* group (with two nephridia) from the west coast of Ireland that is probably the same species as your new one. I thought at first it was *T. gigas*, but have recently procured Müller's paper, and find it is quite different. It was taken from the stomach of a Cod during the Dublin Royal Society Survey. There is no trace of green colour, but in a partly digested specimen that may well have gone."

We must endeavour to obtain some more specimens of

* On a new British Echiuroid Gephyrean, with remarks on the genera *Thalassema* and *Hamingia*, by W. A. Herdman, F.R.S.; "Quart. Journ. Mic. Sci.," December, 1897, p. 367 (with two plates).

this interesting form by trawling in the deep channel (see fig. 6) between Port Erin and Ireland.

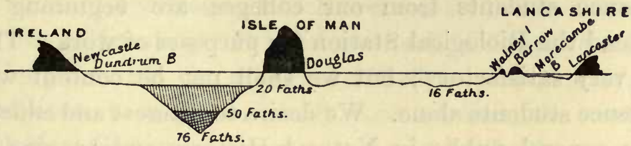


Fig. 6—Section across the Irish Sea through Douglas.

L.M.B.C. Publications.

Since the last Annual Report the following L.M.B.C. papers have appeared in the Transactions of the Biological Society. As usual, extra copies of the sheets have been struck off and stored for publication in volume V. of the "Fauna," which will probably be ready to be issued in a year or so :—

1. Revised list of Hydromedusæ of the L.M.B.C. district, by Edward T. Browne, B.A., F.Z.S.

2. Additional notes on the Turbellaria of the L.M.B.C. district, by H. Lyster Jameson, B.A.

The following may also be noted under this head :—(1) In the Sea-Fisheries Laboratory Report for 1896, there have been published some observations on the development of the Gurnard, the Lemon Sole, and the Witch at Port Erin ; (2) the Catalogue of the Fisheries Collection, in the Zoological Museum at University College, contains a list of Fishes of the neighbourhood—a group upon which we have not yet had a full report ; and (3) Prof. Herdman's paper in the "Quarterly Journal of Microscopical Science" gives an account of the large green *Thalassema* trawled in the deep water off Port Erin.

Concluding Remarks.

As we have recorded, in the earlier part of this Report, science students from our colleges are beginning to attend the Biological Station for purposes of work. That is very satisfactory; but we shall not be content with science students alone. We desire to interest and educate the general public in Natural History, and to give all university students opportunities of studying living nature. Students of science study, to some slight extent at least, Arts subjects—Literature, History, Languages, and, it may be, Philosophy—but how very few of the ordinary Arts students have even the most elementary acquaintance with any experimental or natural science. Fortunately, it is now becoming rare to hear an educated person boasting of ignorance or indifference to science, but it is still very unusual to find anyone who has received a non-scientific education and who understands and appreciates the natural phenomena by which he is surrounded. The elements of nature-knowledge should surely always form part of a liberal education; and a most instructive portion of the course on nature-knowledge would be a couple of weeks spent amongst the researchers at a biological station. It is a revelation and an inspiration to the young student, or the inexperienced, to spend a forenoon on the rocks exploring and collecting with specialists who can point out at every turn the working of cause and effect, adaptation to environment, and the results of Evolution. It is equally instructive and inspiring to have a day at the microscope with, say, our authority on Copepoda, studying the nature and ways of animals which are probably of greater economic importance to the world than the wheat plains of Manitoba or the gold of Klondike.

Biology is the department of human knowledge which more than any other has been at the foundation of those advances of civilization which are most characteristic of the last half century. It has done much in its applications to lengthen life, to relieve its burdens and ameliorate conditions, to improve, purify, and advance the world. Biological Stations have now been adopted by the universities, they will in time be established also in all sea-port towns as municipal institutions. The great French biologist and educationalist, Paul Bert, has spoken of a similar institution to ours, the Station Zoologique d'Arcachon, as "un établissement d'utilité publique de l'ordre de ceux dont, dans d'autres branches, la création incombe à l' Etat."

Nowhere in all the broad field of knowledge will a man learn better to think exactly than in the natural sciences. Nowhere will he be more impressed with the importance of truth, for truth's sake, than when trained in accurate observation and impartial record at a Biological Station.

Appendices on (A), the Constitution and Regulations of the Committee, and (B), the Hon. Treasurer's Statement and List of Subscribers to the Funds, follow as usual.

APPENDIX A.

THE LIVERPOOL MARINE BIOLOGY COMMITTEE (1897).

At the meeting of the Committee held in December, 1896, Lord Henniker and Mr. Hoyle were elected in place of Sir Spencer Walpole and Mr. Vicars, resigned.

R. D. DARBISHIRE, Esq., B.A., F.G.S., Manchester.

PROF. R. J. HARVEY GIBSON, M.A., F.L.S., Liverpool.

HIS EXCELLENCY LORD HENNIKER, Governor of the Isle of Man.

PROF. W. A. HERDMAN, D.Sc., F.R.S., F.L.S., Liverpool, Chairman of the L.M.B.C., and Hon. Director of the Biological Station.

W. E. HOYLE, Esq., M.A., Manchester.

A. LEICESTER, Esq., formerly of Liverpool.

SIR JAMES POOLE, J.P., Liverpool.

DR. ISAAC ROBERTS, F.R.S., formerly of Liverpool.

I. C. THOMPSON, Esq., F.L.S., Liverpool, Hon. Treasurer.

A. O. WALKER, Esq., F.L.S., J.P., Colwyn Bay.

CONSTITUTION OF THE L.M.B.C.

(Established March, 1885.)

I.—The OBJECT of the L.M.B.C. is to investigate the Marine Fauna and Flora (and any related subjects such as submarine geology and the physical condition of the water) of Liverpool Bay and the neighbouring parts of the Irish Sea; and if practicable to establish and maintain a Biological Station on some convenient part of the coast.

II.—The COMMITTEE shall consist of not more than 12 and not less than 10 members, of whom 3 shall form a quorum; and a meeting shall be called at least once a year for the purpose of arranging the Annual Report, passing the Treasurer's accounts, and transacting any other necessary business.

III.—During the year the AFFAIRS of the Committee shall be conducted by an HON. DIRECTOR, who shall be Chairman of the Committee, and an HON. TREASURER, both of whom shall be appointed at the Annual Meeting and shall be eligible for re-election.

IV.—Any VACANCIES on the Committee, caused by death or resignation, shall be filled by the election, at the Annual Meeting, of those who, by their work on the Marine Biology of the district, or by their sympathy with science, seem best fitted to help in advancing the work of the Committee.

V.—The EXPENSES of the investigations, of the publication of results, and of the maintenance of the Biological Station shall be defrayed by the Committee, who for this purpose shall ask for subscriptions or donations from the public, and for grants from scientific funds.

VI.—The BIOLOGICAL STATION shall be used primarily for the Exploring work of the Committee, and the SPECIMENS collected shall, so far as is necessary, be placed in the first instance at the disposal of the members of the Committee and other specialists who are reporting upon groups of organisms; work places in the Biological Station may, however, be rented by the week, month, or year to students and others, and duplicate specimens which, in the opinion of the Committee, can be spared may be sold to museums and laboratories.

LIVERPOOL MARINE BIOLOGICAL STATION at PORT ERIN.

Regulations.

I.—This Biological Station is under the control of the Liverpool Marine Biological Committee, the executive of which consists of the Hon. Director (Prof. Herdman, F.R.S.) and the Hon. Treasurer (Mr. I. C. Thompson, F.L.S.).

II.—In the absence of the Director, and of all other members of the Committee, the Station is under the temporary control of the Resident Curator or Laboratory Assistant, who will keep the keys, and will decide, in the event of any difficulty, which places are to be occupied by workers, and how the tanks, boat, collecting apparatus, &c., are to be employed.

III.—The Resident Curator will be ready at all reasonable hours and within reasonable limits to give assistance to workers at the Station, and to do his best to supply them with material for their investigations.

IV.—Visitors will be admitted, on payment of a small specified charge, to see the Aquarium and the Station, so long as it is found not to interfere with the scientific work. Occasional lectures are given by members of the Committee.

V.—Those who are entitled to work in the Station, when there is room, and after formal application to the Director, are:—(1) Annual Subscribers of one guinea or upwards to the funds (each guinea subscribed entitling to the use of a work place for four weeks), and (2) others who are not annual subscribers, but who pay the Treasurer 10s. per week for the accommodation and privileges. Institutions, such as Colleges and Museums, may become

subscribers in order that a work place may be at the disposal of their staff for a certain period annually; a subscription of two guineas will secure a work place for six weeks in the year, a subscription of five guineas for four months, and a subscription of £10 for the whole year.

VI.—Each worker* is entitled to a work place opposite a window in the Laboratory, and may make use of the microscopes, reagents, and other apparatus, and of the boats, dredges, tow-nets, &c., so far as is compatible with the claims of other workers and with the routine work of the Station.

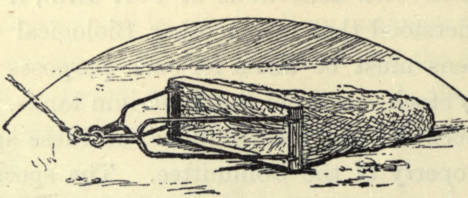
VII.—Each worker will be allowed to use one pint of methylated spirit per week, free. Any further amount required must be paid for. All dishes, jars, bottles, tubes, and other glass may be used freely, but must not be taken away from the Laboratory. Workers desirous of making, preserving, and taking away collections of marine animals and plants, can make special arrangements with the Director or Treasurer in regard to bottles and preservatives. Although workers in the Station are free to make their own collections at Port Erin, it must be clearly understood that (as in other Biological Stations) no specimens must be taken for such purposes from the Laboratory stock, nor from the Aquarium tanks, nor from the steam-boat dredging expeditions, as these specimens are the property of the Committee. The specimens in the Laboratory stock are preserved for sale, the animals in the tanks are for the instruction of visitors to the Aquarium, and as all the expenses of steam-boat dredging expeditions are defrayed by the Committee the specimens obtained on these occasions must be retained by the

* Workers at the Station can always find comfortable and convenient quarters at the closely adjacent Bellevue Hotel; but lodgings can readily be had by those who prefer them.

Committee (*a*) for the use of the specialists working at the Fauna of Liverpool Bay, (*b*) to replenish the tanks, and (*c*) to add to the stock of duplicate animals for sale from the Laboratory.

VIII.—Each worker at the Station is expected to lay a paper on some of his results—or at least a short report upon his work—before the Biological Society of Liverpool during the current or the following session.

IX.—All subscriptions, payments, and other communications relating to finance, should be sent to the Hon. Treasurer, Mr. I. C. Thompson, F.L.S., 53, Croxteth Road, Liverpool. Applications for permission to work at the Station, or for specimens, or any communication in regard to the scientific work should be made to Professor Herdman, F.R.S., University College, Liverpool.



Appendix B.

SUBSCRIPTIONS and DONATIONS.

	Subscriptions. £	s.	d.	Donations. £	s.	d.
Anon. per Prof. Herdman		—		1	1	0
Ayre, John W., Ripponden, Halifax ...	1	1	0		—	
Banks, Prof. W. Mitchell, 28, Rodney-st.	2	2	0		—	
Bateson, Alfred, Harrop-road Bowdon...	1	1	0		—	
Beaumont, W. I., Cambridge	1	1	0		—	
Bickersteth, Dr., 2, Rodney-st.	2	2	0		—	
Brown, Prof. J. Campbell, Univ. Coll....	1	1	0		—	
Browne, Edward T., B.A., 141, Uxbridge-road, Shepherd's Bush, London ...	1	1	0		—	
Brunner, Sir J. T., Bart., M.P., Druids Cross	5	0	0		—	
Boyce, Prof., University College ...	1	1	0		—	
Caton, Dr., 86, Rodney-street		—		1	1	0
Clague, Dr., Castletown, Isle of Man ...	1	1	0		—	
Clague, Thomas, Bellevue Hotel, Port Erin	1	1	0		—	
Claxton, E. J.	1	0	0		—	
Comber, Thomas, J.P., Leighton, Parkgate	1	1	0		—	
Crellin, John C., J.P., Ballachurry, Andreas, Isle of Man	0	10	6		—	
Darbishire, R.D., Victoria-pk., Manchester	1	1	0			
Gair, H. W., Smithdown-rd., Wavertree	2	2	0		—	
Gamble, Col. C.B., Windlehurst, St. Helens	2	0	0		—	
Gamble, F.W., Owens College, Manchester	1	1	0		—	
Gaskell, Frank, Woolton Wood... ...	1	1	0		—	
Gaskell, Holbrook, J.P., Woolton Wood	1	1	0		—	
Gibson, Prof. R. J. Harvey, 5, Adelaide-terrace, Waterloo	1	1	0		—	
Forward ...	£29	10	6	2	2	0

	Subscriptions. £	s.	d.	Donations. £	s.	d.
Forward ...	29	10	6	2	2	0
Glynn, Dr., 62, Rodney-street	2	2	0		—	
Gotch, Prof., Museum, Oxford	1	1	0		—	
Halls, W. J., 35, Lord-street	1	1	0		—	
Hanitsch, Dr., Museum, Singapore ...	1	1	0		—	
Henderson, W. G., Liverpool Union Bank	1	1	0		—	
Herdman, Prof., University College ...	2	2	0		—	
Holland, Walter, Mossley Hill-road ...	2	2	0		—	
Holt, Alfred, Crofton, Aigburth	2	2	0		—	
Holt, Mrs. George, Sudley, Mossley Hill	1	0	0		—	
Hoyle, W. E., Museum, Owens College, Manchester	1	1	0		—	
Isle of Man Natural History and Antiquarian Society	1	1	0		—	
Jameson, H. Lyster, Dublin	1	0	0		—	
Jones, C.W., J.P., Field House, Wavertree	1	0	0		—	
Kermode, P. M. C., Hill-side, Ramsey...	1	1	0		—	
Lea, Rev. T. Simcox, 3, Wellington-fields	1	1	0		—	
Leicester, Alfred, Buckhurst Farm, Edenbridge, Kent	1	1	0		—	
Macfie, Robert, Airds	1	0	0		—	
Meade-King, H. W., J.P., Sandfield Park	1	1	0		—	
Meade-King, R. R., 4, Oldhall-street ...	0	10	0		—	
Melly, W. R., 90, Chatham-street ...	1	1	0		—	
Monks, F. W., Brooklands, Warrington	1	1	0		—	
Mundy, Randal, Manchester	0	10	0		—	
Muspratt, E. K., Seaforth Hall	5	0	0		—	
Newton, John, M.R.C.S., 44, Rodney-st.	0	10	6		—	
Poole, Sir James, Tower Buildings ...	2	2	0		—	
Pratt, Miss, Manchester	1	0	0		—	
Rathbone, S.G., Croxteth-drive, Sefton-pk.	2	2	0		—	
Rathbone, Mrs. Theo., Backwood, Neston	1	1	0		—	
Forward ...	£67	6	0	2	2	0

	Subscriptions. £	s.	d.	Donations. £	s.	d.
Forward ...	67	6	0	2	2	0
Rathbone, Miss May, Backwood, Neston	1	1	0		—	
Rathbone, W., Greenbank, Allerton ...	2	2	0		—	
Reade, M. T., Blundellsands		—		3	0	0
Roberts, Isaac, F.R.S., Crowborough ...	1	1	0		—	
Simpson, J. Hope, Annandale, Aigburth-dr	1	1	0		—	
Smith, A. T., junr., 24, King-street ...	1	1	0		—	
Talbot, Rev. T. U., 4, Osborne-terrace, Douglas, Isle of Man	1	0	0		—	
Thompson, Isaac C., 53, Croxteth-road	2	2	0		—	
Thornely, James, Baycliff, Woolton ...	1	1	0		—	
Thornely, The Misses, Baycliff, Woolton	1	1	0		—	
Toll, J. M., Kirby Park, Kirby	1	1	0		—	
Walker, A. O., Nant-y-glyn, Colwyn Bay	3	3	0		—	
Walker, Horace, South Lodge, Princes-pk.	1	1	0		—	
Walters, Rev. Frank, B.A., King William College, Isle of Man...	1	1	0		—	
Watson, A. T., Tapton-crescent, Sheffield	1	1	0		—	
Weiss, Prof. F. E., Owen's College, Man'tr.	1	1	0		—	
Westminster, Duke of, Eaton Hall ...	5	0	0		—	
Wiglesworth, Dr., Rainhill	1	1	0		—	
Yapp, R. H., Cambridge...	0	10	0		—	
	£93	15	0	5	2	0

SUBSCRIPTIONS FOR THE HIRE OF "WORK-TABLES," OCCUPIED BY COLLEGES, &c.

	£	s.	d.
Owens College, Manchester	£10	0	0
University College, Liverpool	10	0	0
	£20	0	0

THE LIVERPOOL MARINE BIOLOGY COMMITTEE.

Dr. IN ACCOUNT WITH ISAAC C. THOMPSON, HON. TREASURER. **Cr.**

1897.	£	s.	d.
To Balance due Treasurer, Dec. 31st, 1896	4	10	9
,, Printing Reports	16	6	3
,, Printing and Stationery	0	12	0
,, Expenses of Dredging Expeditions	35	1	6
,, Boat Hire	2	1	6
,, Books and Apparatus at Port Erin Biological Station	17	2	7
,, Postage, Carriage of Specimens, &c.	1	10	6
,, Salaries, Curator and Laboratory Boy	35	1	1
,, Rent of Port Erin Biological Station	15	0	0
,, Repairs	0	16	8
,, Sundries	2	7	2
	£130	10	0

1897.	£	s.	d.
By Subscriptions and Donations actually received	92	11	0
,, Amount received from Colleges, &c., for hire of "Work Tables"	20	0	0
,, Dividend, British Workman's Public House Co., Ltd., Shares	5	18	9
,, Sale of Reports and Volumes of Fauna	3	6	0
,, Interest on British Association Fund	2	12	5
,, Bank Interest	0	8	0
,, Admissions to Aquarium	2	18	6
,, Balance due Treasurer, Dec. 31st, 1897	2	15	4
	£130	10	0

Endowment Investment Fund :—
British Workmans' Public House Co's. shares £173 1 0

ISAAC C. THOMPSON,
HON. TREASURER.

Audited and found correct,
A. T. SMITH, JUNR.

LIVERPOOL, *December 31st* 1897.

L.M.B.C. NOTICES.

The public are admitted by ticket to inspect the Aquarium at suitable hours daily, when the Assistant will be, as far as possible, in attendance to give information. Tickets of admission, price threepence each, to be obtained at the Biological Station or at the Bellevue Hotel. The various tanks are intended to be illustrative of the marine life of the Isle of Man. It is intended also that short lectures on the subject should be given from time to time by Prof. Herdman, or by others of the Committee.

Applications to be allowed to work at the Biological Station, or for specimens (living or preserved) for Museums, Laboratory work, and Aquaria, should be addressed to Professor Herdman, F.R.S., University College, Liverpool.

Subscriptions and donations should be sent to Mr. I. C. Thompson, F.L.S., 53, Croxteth Road, Liverpool.

The surplus copies of the five Annual Reports upon the Marine Biological Station formerly on Puffin Island (1888 to 1892, the complete set) have been collated and bound up to form an 8vo. volume of about 180 pages, illustrated with cuts and plates, and containing the original lithographed covers. There are 20 copies of this vol., which are now offered by the Committee at 3/- each nett.

Copies of the Annual Reports for 1893, 1894, and 1895 can also be had, price one shilling each (all post free).

The L.M.B. Committee are publishing their Reports upon the Fauna and Flora of Liverpool Bay in a series of 8vo. volumes at intervals of about three years. Of these there have appeared :—

Vol. I. (372 pp., 12 plates), 1886, price 8/6.
Vol. II. (240 pp., 12 plates), 1889, price 7/6.
Vol. III. (400 pp., 24 plates), 1892, price 10/6.
Vol. IV. (475 pp., 53 plates), 1895, price 10/6.

Copies of any of the above publications may be ordered from the Liverpool Marine Biology Committee, University College, Liverpool, or from the Hon. Treas., 4, Lord Street, Liverpool.

Isaac C. Thompson,
Hon. Treas.

ON THE CORPUSCLES OF CERTAIN MARINE WORMS.

By Lionel J. Picton, B.A.

[Read Dec. 10th, 1897.]

With Plate IX.

In comparing simple organisms with higher animals, a part is often remarked with a common origin and similar function in both, but relatively much better developed in the so-called "low" animal than in the higher. Three quarters of the bulk of a Tunicate, for instance, may consist of the walls of the pharynx only; again in certain Crustacea, the eyes may occupy a third of the body. It is quite evident, in such cases, that the parts in question, pharynx or eyes, as the case may be, are of much greater importance to the Tunicates, or Crustacea, than the corresponding organs in ourselves, for instance, are to us.

The subject with which I am to deal is a similar case. The primitive body cavity in a healthy mammal is a cavity only in name. I need not remind you that the fluid which is contained in it is normally very small. It has collapsed, like that of a bag emptied of its contents, to use the familiar explanation, and the little fluid that remains just suffices to moisten the adjacent surfaces. If there be more fluid, then, of course, we have a pathological condition, as in pleurisy.

In many invertebrata, however, the coelom is large and open, and filled with a corpusculated fluid. Differences,

in the relations obtaining in different groups of animals between the coelom, on the one hand, and the blood vascular system on the other, have diverged along two lines. The common condition is for the blood vessels to be cut off entirely, or almost entirely, from the body cavity. There is no open connexion between the two in vertebrata and most Chætopod worms. There are two modifications of this state, along divergent paths, but leading to one result, the blending of the blood and coelomic fluid in a common liquid. In Arthropods the blood vascular system is so well developed that the body cavity proper, becoming proportionately diminished, is eventually practically obliterated. The veins cease to exist as such, but are swollen out into enormous sinuses, in which the organs of the body may be said to float. The blood alone must do the work of blood and coelomic fluid, and is, no doubt, specially modified for the double task. The state of affairs in the leeches, little of the coelom remaining, and the blood vessels being well developed, represents a halfway house to this stage.

The alternative case is when a modification took place exactly the opposite to that in the case of Arthropods. I refer to the condition found in certain Polychæta, the Capitellidæ, the Glyceridæ, and Polycirrus amongst the Terebellidæ. In these, the blood vascular system, instead of enlarging, has dwindled, whilst the coelomic fluid has taken on the double function, both that one proper to itself, and also the respiratory function proper to blood. Even in developing Capitellidæ—as I was told by Professor Eisig, who is just finishing his studies on the embryology of the group — even transitory blood vessels do not appear, except in a few doubtful instances. This shows how complete has been the curious alteration in the ménage of this little organism. For the resulting

combined fluid of blood and lymph, Eisig has proposed the name "Hæmolymph," as indicating the two sources of its origin and the double function it performs. Both in Arthropoda and in certain Polychæta, then, a combined fluid is formed, though by two entirely different processes, which represents blood and perivisceral lymph, fluids which are separate in vertebrata and in the majority of Chætopod worms.

There is an astonishing variety in the corpuscles in the body-fluids of different worms. Species very closely allied may show extraordinary differences in this respect.

It is hopeless, at present, to attempt to be comprehensive; in such an untrodden country, we may pass straight to one point of interest, a certain peculiar corpuscle which I came across in the hæmolymph of *Notomastus profundus*, a Capitellid worm. After describing it I shall endeavour to compare it with the corpuscles of other worms, which will be incidently described.

The worm is common in certain beds of sea-weed in the Bay of Naples. It is of a reddish colour and about two inches long. An excellent description of the corpuscles of the hæmolymph is to be found in Eisig's monograph on the group. He recognises two kinds, small, colourless amœboid leucocytes, and large flattened disc-shaped corpuscles, which are of a yellow colour due to hæmoglobin, the latter are nucleated, and contain large brown chitinous concretions, which show a concentric marking. Eisig thinks that the concretions represent degeneration stages of hæmoglobin.

Besides these two kinds of corpuscles, I have found a third (figs. 3 and 4) occurring in relatively much smaller numbers than the others, but, nevertheless, present in every specimen of the hæmolymph which I have examined. It varies considerably in size, but frequently reaches a

diameter of ·05 mm., or about three times the diameter of the disc-shaped corpuscles. It consists of a single cell of colourless protoplasm containing in its substance a solid, refringent rod. The rod is exactly the shape of a bow, thicker in the middle than at the tapering and recurved tips. Over the ends and convex side the protoplasm stretches in a thin layer. On the concave side the body of the cell is placed, occupying the space between what would be the line of the bow string and the rod itself. The nucleus is placed close to the rod on its concave side, and very often it lies to one side of the rod, partially covered by it, or lying over it, according to the side on which the corpuscle is lying in the preparation. The nucleus stains with hæmatoxylin, but not deeply; it is noticeable that the thin cap of protoplasm which covers the tips of the rods also stains with hæmatoxylin. From both convex and concave side filamentous processes of protoplasm stretch out, which may be seen in fresh preparations, slowly waving about backwards and forwards. Those on the convex side may be all slightly curved, to the same degree and in the same direction. The processes, especially on the concave side, are often engaged in toying with the disc-shaped corpuscles. With the exception of a few vacuoles I have seen nothing else in the protoplasm.

The rod itself is of a pale yellow colour. It appears in a few corpuscles which seem to be degenerating, to be slightly out of shape; and in small ones may be more bent than in the larger. As a rule, however, it preserves an uniform appearance like that of a strung bow. One can sometimes see in it longitudinal striations. Viewed by polarized light, it appears of a different colour to the rest of the field, an indication that it is no optical appearance only, but is, in fact, a structure. It is also noteworthy

that it has the same action on polarized light as chitin; * and as it is insoluble in cold 30% caustic potash, or when warmed in 25% caustic potash to 130° F., while it swells up with strong HCl, it is safe to conclude, not indeed that it is identical with chitin, but at any rate that it is of a similar nature.†

With regard to the development of the bow-shaped corpuscle I can say nothing certain. I have noticed in the hæmolymph, however, small corpuscles similar to the amœboid kind described by Eisig, but differing from them in being of a fusiform shape and in containing a short, straight, colourless rod (fig. 1). It is possible that these are the forerunners of the bow-shaped corpuscles. On the other hand, it is to be noticed that as a rule the smaller the corpuscle the greater the curve of the bow.

Having now described this curious body, it may be asked, "But is it a corpuscle at all?" I confess that when I first met it in a film of hæmolymph, I regarded it merely as a parasite. Finding that the organisms occurred in other films however, and that by searching they could always be found scattered about in any film of hæmolymph, one was more and more impressed with the possibility of their being true corpuscles. No gregarine or other unicellular parasite is known, so far as I am aware, which resembles such a structure. That the rods might be setæ of the worm engulphed by a leucocyte is highly unlikely. When setæ are found in the coelom of worms, as is commonly the case, they are engulphed by a plasmodium formed of numbers of leucocytes, whereas the bow-cells have never more than one nucleus. Again,

* I have to thank Prof. Paul Mayer, of the Zoological Station at Naples, for pointing this out.

† Dr. Gustav Mann noticed that the rod seems to be transversely flattened on its concave side.

the setæ are much larger than the rods, are blunt at one end and pointed at the other, and have well marked characteristics which differ entirely from the well defined bow-shape of the rods. That the bow-cells may be cells of some fixed tissue seems equally unlikely. A diagram of a bow-cell and a diagram of a smooth muscle-cell, it is true, present a general resemblance, and it was suggested to me that the contraction of the muscular element in the isolated cell might produce the characteristic arcuate shape; this, however, is quite impossible, seeing that the rods are rigid when rolled over in a fresh preparation, by means of gently tapping the coverslip, and also in view of the fact that the rod is unaffected by caustic potash, and is therefore not a muscular fibre, but is of a similar nature to chitin. That the bow-cells have been accidentally isolated from any other fixed tissue seems equally unlikely. What fixed tissue shows cells with long waving filamentous pseudopodia distinct from cilia? Only alternative conclusions remain to us, either that the problematical body is a parasite differing from any known parasite, or that it is a corpuscle.

It may be said that in fairness, one should add, "differing from any known corpuscle." But it will have occurred already to the reader that the bow-cells have much in common with the well-known rod-cells of the Polychæte, *Ophelia radiata* (fig. 5). Ever since Claparède discovered and described these remarkable bodies, they have been regarded as unique, and the opinions that they are parasites or corpuscles have been variously held. Schaeppi, however, has shown conclusively that they are corpuscles.*

The rods in the corpuscles of *Ophelia* are so large as to be visible to the naked eye. They are of a deep

* Schaeppi, Jen. Zeitsch. f. Nat. Wiss., 1894, p. 246.

brown colour; darker in the middle than at the ends, whilst the ends are broader than the middle; notched; and often forked. The rods are contained in single cells of colourless protoplasm, with a nucleus lying in a slight depression in the middle of the rod. The protoplasm extends as a very attenuated layer over the ends of the rods, and in the middle region sends out filamentous, slowly waving processes. A few granules and vacuoles occur in the cell substance. Schaeppi gives an excellent account of the formation of the rods by several green granules in a cell fusing in one alignment, and of their growth at the ends, where the tension of the protoplasm is obviously greater than at the centre, entailing the deposition of the fresh granules on the extremities. He shows that the substance of which the rods are formed is certainly chitin, and regards it as being derived from the nucleus of the corpuscle. The function of the corpuscle, he considers, to be excretory. With the exception of the two last points, the account is excellent; but that excretion is the function of the corpuscles, whilst the only substances which they are to excrete are the degeneration products of the nucleus of the cell, seems to me impossible. If every other nucleus in the body had such provision for its excretion, the result can hardly be imagined. Be that as it may, Schaeppi's account leaves no doubt that the rod-cells of *Ophelia* are corpuscles.

No other rod containing corpuscles have been described throughout the animal kingdom, so far as I am aware; but, on the other hand, it is the commonest thing to find deutoplastic products in blood and coelomic corpuscles. Some of these are of a very remarkable nature, and, though differing in form, may have a similar raison d'être to the bow-cells. I may take an instance from Oligochæta

of these deutoplastic products in corpuscles. My friend, Mr. E. S. Goodrich, has described a remarkable structure in certain of the coelomic corpuscles of the oligochæte worm, *Enchytraeus hortensis*.* It consists of a refringent, thick disc, its flat surface next the nucleus of the corpuscle. When the disc comes in contact with distilled water, or even salt solution, it appears that it is really formed of a long thread of transparent, homogeneous substance, coiled like a rope. The thread, after making its appearance after coming in contact with a foreign liquid, gradually unwinds, forming a tangle of loops; but no ends have ever been seen. The thread is stained yellowish brown with iodine, is dissolved with difficulty on heating with caustic potash, and, with acetic acid, is first turned into a coagulated mass, and then for the most part dissolved. Thus the chemical nature of the thread is obscure. I have noticed somewhat similar threads in the coelomic fluid of *Chætopterus*.

These rods and threads are instances of the occurrence of deutoplastic products in corpuscles. The chief points about them which demand explanation are, perhaps, the curious variety of forms they assume; their chemical nature, origin, and fate; and their purpose.

Their forms are, perhaps, partly dependent on mechanical forces acting within the cell; but Schaeppi makes the significant statement, with regard to *Ophelia*, that whereas chlorogogen—he is speaking of chitinous chlorogogen—is secreted only on one side of a nucleus, guanin is secreted all round it. For this, at any rate, there is no obvious mechanical reason.

I have already dealt with the chemical nature of the products.

* Goodrich, "Quar. Jour. Micr. Sci.," vol. XXXIX., part 1, p. 57.

With regard to their purpose, no proposal can be confidently advanced. That which occurs to the mind first is, that they may assist in absorbing waste products out of the coelomic fluid, forming them into a shape suitable to excretion, and then casting them out. In favour of this, we have the analogy of the ciliated-pots of that curious animal *Sipunculus nudus* (fig. 6). These are globes consisting of one transparent cell, which is furnished with a sort of crown of cilia, set in a ring of firm consistency. The ring appears to me to be nucleated, that is to say, to be a second cell, though that is not the received description.

These ciliated-pots may be observed in a fresh specimen of the hæmolymph, creating circles of disturbance amongst the remainder of the corpuscles. When brought to rest by the pressure of a cover glass, their shape can be made out; and it can also be ascertained—and this is the point on which I wish to lay stress—that they have collected within their ring of cilia, a mass of brownish débris, evidently the waste products they have met in the coelom.

That is so much direct evidence that these curious and elaborate corpuscles have an excretory function. It is possible that the rod and bow-cells collect excretory matter, in an analogous, though not so obvious a way, and with it build up the rods and bows.

On the other hand, it may be argued that ordinary phagocytes are present in all these worms to subserve excretion, and that our special corpuscles must have other special functions.

The only other function which occurs to me as likely is one in connection with the defence of the animal against hostile organisms. In *Trophonia* I have found structures in the coelomic fluid which were obviously of this nature (fig. 7). These were solid figure-of-8-shaped

bodies, enclosed in a sheath of two or three cells, which usually contain bright globules. The globules were shown to be fat by the fact that they stained with the new fat stain, Soudan III. Inside the figure-of-8-shaped body was a central, dark rod, staining with hæmatoxylin. It seems to me highly probably that the latter is some micro-organism, ensheathed by the corpuscles of the worm to prevent it doing harm. Metchnikoff has figured similar bodies in the spleen of the Jerboa, and Jourdan in the coelomic fluid of *Siphonostoma*.

It is also well-known that corpuscles of Chætopods attack a parasitic nematode, and the sheath of chitin, which is formed round the latter, has been shown only this year by Cuènot to be formed, not by the nematode, as Metchnikoff thought, but by the leucocytes.

This shows a wonderful power in the leucocytes of producing an enormous amount of chitin at a given moment. This seems to me to suggest the possibility that in the worms possessing the remarkable corpuscles I have mentioned, the chitinous rods represent a reserve of defensive material preserved in this form till required. I may mention that the same idea had suggested itself to Mr. Goodrich, with whom I talked the matter over.

Explanation of Plate IX.

Figs. 1—4. *Notomastus profundus*, Hæmolymph.

Fig. 1. Fusiform corpuscle, possibly an early stage of the bow-cell. A rod-like structure is seen within it. Fresh, × 480.

Fig. 2. Hæmolymph, showing ordinary cells and three bow-cells. The nuclei are stained. From a photograph, kindly taken by Dr. Gustav Mann.

Fig. 3. Bow-cell, showing filamentous processes. Fresh, × 480.

Fig. 4. Bow-cell, the processes of which are playing with one of the hæmoglobinous corpuscles. The latter shows the usual chitinous body within it, with concentric markings. Fresh, × 480.

Fig. 5. Diagram of one of the rod-corpuscles of *Ophelia radiata.*

Fig. 6. Diagram of one of the ciliated-pots of *Sipunculus nudus.*

Fig. 7. Figure-of-8-shaped concretion with nucleated envelope, from coelomic fluid of *Trophonia plumosa.* Hæmalum; the nuclei and central line were stained. × 480.

BURIED BONES ABOUT LIVERPOOL.

By G. H. Morton, F.G.S.

[Read Dec. 10th, 1897.]

Large bones have for many years been found in making excavations for buildings in various places about Liverpool, and have occasionally excited considerable interest, for they were often thought to be the remains of some extinct species. On examination, however, they have generally been found to be those of whales. They were larger than those of any other animal, and had the peculiar vesicular structure of Cetacean bones, which causes them to be sufficiently buoyant for an animal living in the sea.

Towards the end of the last and the beginning of the present century, the whale fishery trade was vigorously carried on in Liverpool. The first vessel engaged in it was the "Golden Lion,"* in 1750, a prize taken from the French. In 1764 three ships took part in the trade, but the first whaler built in the town was the "William" † in 1775, and the last in 1823; the greatest number of vessels employed was in 1788, when there were 23 so engaged. In 1823, the "Baffin," the last of the whalers, was commanded by Captain Scoresby, who was afterwards well known for his scientific attainments. The "William" † was engaged in the trade for 50 years, and after that served as a Seaman's Chapel in the King's Dock. Captain Scoresby, after his retirement from the sea, was for some years the chaplain of the Mariner's Church in the George's

* "Liverpool during the Last Quarter of the 18th Century."

† "Memorials of Liverpool."

Dock, originally the "Tees,"* a government guardship. On the 7th of June, 1871, she sank from decay, and there has been no such floating church since, the "William" having perished in 1851.

In Greenland Street there was a boiling house, and both that and Baffin Street were named during the period referred to. It does not seem to have been necessary to bring home the large bones of the whale with the blubber, but that they were imported is certain. They were probably brought home as curiosities and disposed of to people who had a fancy for such objects, only the largest possessing much interest, and this is the only explanation of so many having been found buried in the soil and clay in so many different places. The retired whaling captain would delight in having the lower jaw-bones of a whale forming the entrance to his garden, and other people seem to have obtained and ornamented their grounds with them in a similar fashion. The vertebræ and the larger bones of the fore-limbs or flippers were placed in gardens as curiosities from the sea, and the jaw-bones were placed on end and formed a sort of Gothic archway. The latter were evidently sometimes used instead of timber in the construction of rough erections, such as the cart shed in a farm yard in Barlow Lane off Walton road, a representation of which is given in Herdman's "Pictorial Relics of Ancient Liverpool," as the "Whale-bone shed," Pl. LIII. (3). It was formed of four lower jaw-bones placed one behind another and with the intervening spaces filled in with wooden planks. The drawing shows that the two ends of the jaw-bones were fastened together at the top, and the distance between the basal ends could be regulated as required, and consequently gave no measure of the original width of the mouth of the whale.

* "Ancient Liverpool."

After the whaling trade had declined in Liverpool, Cetacean bones would lose much of their interest, and often be regarded as useless lumber, and buried in the ground, that being the most ready and economical mode of getting rid of them. It was, however, not easy to dispose of the jaw-bones on account of their great length, but as they had generally been erected on end with the frontal margin upwards, they occupied very little space, and were allowed to remain until the land was required for building purposes.

Fifty years ago there were many of these jaw-bones left standing, but only two now remain, most of the others having been buried, for they were of little if any value. They were, however, interesting monuments of Liverpool as it was a hundred years ago, and, as they will now be soon forgotten, a short notice of them and other similar relics may be of interest, and as I have been frequently asked to give an opinion on such buried bones, the subject has been constantly on my mind for many years.

In the Zoological Gardens in West Derby Road, opened in 1833, there were the lower jaw-bones of a whale set up across a narrow walk leading up to the higher portion of the grounds, and, as well as I can remember, about twelve or fourteen feet high, and six or seven feet wide at the base where fixed in the ground. The actual length may have been about fifteen feet, but as they would be detached when brought home, the width between the opposite sides at the base of the jaw must have been uncertain. They remained fixed until the gardens were closed in 1863. In 1840 there were similar jaw-bones set up at the entrance to a market garden at the top and north corner of Fairclough Lane, and remained there until houses were erected on the site. Many years ago there were the lower jaw-bones standing erect on the

south side of James Street,* and on the south-west side of Breckfield Road North, near St. Domingo Pit, in which they were found fifty years ago and then fixed up in a garden at the north end of it, on the site of the present Chambers Street. There were others on the east side of Boundary Lane,† over the entrance to the Strawberry Gardens, where a brewery now stands, and on the south side of Everton Brow,‡ just below Prince Rupert's Cottage. There were lower jaw-bones on the west side of Lodge Lane,§ and at Little Brighton, near the old quarry, now a recreation ground on the west of the road, but all these bones have long since disappeared. The "Jaw-Bone Hotel," at Litherland Road, Bootle,|| commemorates another example of the lower jaw-bones of a whale, but removed long ago.

At the top of Holt Hill, Tranmere, on the north side of the road, the lower jaw-bones of a large whale still remain standing thirteen feet above the ground, the distance between the ends of the two rami being thirteen feet, and the width of each one and a half feet. The top ends have fallen across each other in consequence of the basal ends not having been buried a sufficient depth in the ground, their original position having been altered by the removal of the door within which they are placed. It seems probable that the two ends were then set too far apart, and at a greater distance than before, and that eight or nine feet between the articular ends would be more nearly correct. An elderly lady who resides at the house, informed me that "a captain presented the jaw-bones to her grandfather, and that he had them erected."

On the south side of Ibbotson's Lane, Greenbank, over the entrance to the garden of a cottage, the lower jaw-

* Seen by Mr. Fitzpatrick. † Dr. Nevins. ‡ Mr. W. J. Blundell.
§ Mr. F. P. Marrat. || Mr. Thomas Martin.

bones of a whale are still standing, and have been there for many years. They extend nine feet above the ground in which they are fixed, and the width between at the base is four feet, and they evidently belonged to a smaller whale than usual. With the exception of those in the Zoological Gardens, all these jaw-bones were fixed over gates or door-ways leading into gardens and other enclosures.

Some twenty-five years ago the inhabitants of Everton were surprised by some large bones being found buried in the ground somewhere about Whitefield Lane, and there was some speculation as to the kind of beast to which they had belonged, for by that time few people remembered the whale-fishery trade, and were not familiar with such bones, which proved to be those of a whale.

Twenty years ago I was invited to inspect some large bones supposed to be those of an extinct gigantic animal, which had been recently placed on the grounds of the hotel at Hightown Station. After some scepticism, my opinion that they were the bones of whales was accepted. They may still be seen there, and include the fore-limb bones of more than one whale, and part of a ramus. I afterwards ascertained that they were all found buried on the site of the old "Waterloo Hotel," when it was taken down for the erection of the Central Station in Ranelagh Street. I remember a large vertebra being found in the open space between Bold Street and Renshaw Street, now the site of the Midland Railway. It was about two feet in diameter, and was considered a wonderful find by many when discovered, but I do not know what became of it. It was probably buried again, and may astonish a future generation.

Again, about ten years ago I was invited to see a large bone just found in lowering the floor of the cellar in a

warehouse on the north side of Henry Street, behind Duke Street. It proved to be the humerus of the fore-limb of a whale, and was five feet in length, and must have belonged to a very large individual. It had been buried before, or at the time the warehouse was built, probably in the garden of a house in Duke Street. Besides these, I have heard of other such bones being found, but did not always consider it worth while going to see them, and the localities are now forgotten. The ramus of a whale was seen during excavations at University College* in the debris filling "Brooke and Seacomb's quarry," but the only bones, other than the jaw-bones, exposed in the neighbourhood now are two scapulæ—large fan-shaped bones—set up in front of a cottage in Wavertree village, and the lumbar vertebra, with the transverse processes, in a rockery on the north side of Swiss Road, Elm Park.

All the bones described appear to have belonged to the Greenland whale, *Balœna mysticetus*, which has been found from sixty to seventy feet, and sometimes as much as eighty feet in length. Last year a single ramus of the lower jaw of a whale was found in the nets of the steam trawler "Jackdaw," and it was presented to the Free Public Museum, where it now remains. It is seventeen feet in length and one and a half feet wide, and has the articular termination.

Vertebræ and rib-bones of whales have been found in the post-glacial deposits at Wallasey Pool, belonging to young individuals, about twenty-five feet in length, which had perished in the shallow water of Liverpool Bay, as several have done in recent years, and I have seen at least three of them.

* Dr. Herdman.

Many years ago the bones of a gigantic animal were discovered in making an excavation somewhere about Bold Street, and considerable excitement was the result, until some old resident remembered that an elephant that had died in a menagerie had been buried there.

Twenty years ago the horns of *Bos taurus* were found in making the foundation of some buildings on the north side of Lord Street, near the edge of the "Old Pool" which formerly ran along what is now Whitechapel and Paradise Street, and, in 1894, in excavating for the site of the new post-office, some hundreds of such horns were discovered. The cores only remained, the horny sheath having been removed, and I ascertained that a tannery once existed on the spot.

Human bones and skeletons have also been found at various times and places, some of persons supposed to have been murdered, and of ship-wrecked sailors, and others of a soldier of William III., near Egremont, and of men who fell during the siege of the town 250 years ago.

The large boulders occasionally found in the boulder clay, during excavations, are usually buried, that course being the most easy mode of disposing of them. The two large boulders, striated by ice, on the east side of the Free Public Museum, one from an excavation in Hackin's Hey and the other from a dock at Bootle, would have been buried had not the late Sir James A. Picton caused them to be brought away and placed in their present position. In constructing the sewers under the streets boulders are sometimes met with, and are then forced into a side cavity or a hole below made for their reception. Many years ago at least two large boulders were to be seen on the shore at Egremont, where they had fallen from the cliffs, but they have long been removed as they were dangerous to boats when the tide was up.

Since this paper was read, I have heard that a large scapula of a whale was found in excavating a foundation under some cottages in Orange Street, Tithebarn Street, in February, 1870. It measured forty inches in both length and breadth, and was in the possession of the late Mr. Robert Macfie.

THE ELEPHANT IN CHESHIRE.

By G. H. Morton, F.G.S.

With Plate X.

[Read Dec. 10th, 1897.]

Early in the year 1845, a few months after I began to study geology and natural history, I examined the Boulder Clay along the south shore, beyond the Dingle, hoping to find the bones or teeth of the Elephant, but did not succeed in finding either. For forty years after, I remembered making that useless search, but some years ago found that it was not quite such an absurd waste of energy as I had considered it to be, for although no remains of the elephant have been recorded from Lancashire, the bones and teeth have been found in several places in Cheshire during the present century.

In 1803, during the excavation of the Ellesmere Canal, near the village of Wrenbury, the femur of *Elephas primigenius*, four feet in length, was found. It was placed in the museum of William Bullock, in Liverpool, and in 1819 was sold by auction with the rest of his collections, at 22, Piccadilly, London. In a priced catalogue of the collections, "The Thigh-bone of the Mammoth, very large," was sold to Mr. Clift, for the "Surgeon's Museum," for £14 3s. 6d., but I could not find or obtain any information about it at the Royal College of Surgeons, neither is it in the catalogue of the museum published many years ago.

In the catalogue of the museum of the Royal Institution, Liverpool, the following elephantine remains occur at page 76:—

"No. 1927. Mammolithus, fragment of the skeleton of *Elephas primigenius*, or Mammoth.	Sandbach, Cheshire. J. B. Aspinall.
No. 1928. Mammolithus, part of a Grinder of the same, found in a bed of Sand, near	Sandbach, Cheshire. J. B. Aspinall."

The collections were sold to the Corporation of Nottingham in 1877, and to the Earl of Derby and the Corporation of Bootle about 1887. Recently I made a search in the Bootle Museum for the tooth and "fragment of the skeleton" referred to, and found the part of the tooth with the label obliterated, but by means of some chemical treatment the printed description came out distinctly as "1928" in the catalogue. Mr. H. C. Chadwick very kindly made two drawings of it, one showing the grinding surface and the other the side aspect, and one is reproduced on Plate X., fig. 1. The tooth is evidently that of *Elephas primigenius* as given in the catalogue, and the "fragment of the skeleton" is the lower portion of the humerus.

In 1877 a tooth of the elephant was found by a workman in the sand and gravel pit at Marbury, only three miles from Wrenbury, where the femur was found in 1803. It was given by him to a gentleman in the neighbourhood, who, some twelve months after, gave it to the Rev. T. W. Norwood, F.G.S., and he presented it to me in 1897. When I received it all the grinding surface had gone, and the tooth in a broken and delapidated condition, but there is little if any doubt that it belonged to *Elephas primigenius*. In order to preserve it from further decay, the cracks and crevices have been filled with cement and the whole varnished, and the tooth is shown in the photograph, for which I am indebted to Mr. J. A. Clubb, M.Sc., reproduced on Plate X., fig. 2.

A tooth of the elephant is reported to have been found at Northwich, and Professor Boyd Dawkins refers to it as *Elephas primigenius*, but gives no particulars about it, or as to whether it has been preserved. In the Monograph on "British Fossil Elephants," by Dr. A. Leith Adams, F.R.S., *Elephas primigenius* and *E. antiquus* have both been recorded from Cheshire. Professor Boyd Dawkins has recorded *Elephas antiquus* as occurring at Copen Hall, but he no doubt refers to Coppenhall in Cheshire, and so adds another species and a fourth locality. These localities are not far apart, for they are all situated along a curved line twenty-two miles in length, between Northwich on the north and Marbury on the south.

The strata at Wrenbury and Marbury, where the femur and tooth were found, are the "Middle Sands" of the glacial deposits, and they are not only well developed in those localities, but also at Northwich and Sandbach, and probably at Coppenhall, for they cover the whole of the level land of Mid-Cheshire, and are of such a considerable thickness that little can be seen of the underlying Boulder Clay and Keuper Marl.

The "Middle Sands" are very feebly developed around Liverpool, but in the district referred to must often be one hundred feet in thickness, and represent an interval when the sea was comparatively clear of the ice, which caused the deposition of the Boulder Clay, both below and above the "Middle Sands." The deposit is principally sand, but contains occasional and sometimes thick beds of gravel, and in some places many species of mollusca. The Rev. T. W. Norwood has collected about twenty species in the "Middle Sands" at Marbury.

It was in the "Middle Sands" that all the teeth and bones described were found, and as both *Elephas primi-*

genius and *E. antiquus* occur in caves in Derbyshire and North Wales, it seems probable that they drifted from those areas and are of Pre-glacial age, as inferred by Professor Boyd Dawkins.

Explanation of Plate X.

Fig. 1. Tooth of *Elephas primigenius*, from Sandbach. Half natural size. Now in the Bootle Museum.

Fig. 2. Tooth of *Elephas primigenius*, from Marbury. Half natural size.

MALACOSTRACA FROM THE WEST COAST OF IRELAND.

By Alfred O. Walker, F.L.S.

[Read Dec. 10th, 1897.]

In presenting the following list of Malacostraca, chiefly from the West of Ireland, and especially from Valentia Harbour, a few introductory remarks on my visit to that locality will not, I hope, be considered out of place.

On Aug. 21st, 1896, in consequence of an invitation from Mr. E. T. Browne, I arrived at Valentia. Here I found Prof. Weiss, Messrs. Brown, F. W. Gamble, Beaumont, and Hill already established. Mainly through the kind assistance of the Rev. A. Delap, Vicar of Valentia, they had secured a large building known as Fishmonger's Hall, and used as a recreation room by the fishermen who resort to Valentia in the mackerel season. It consisted of a large room with good windows, each provided with a large deal table, and two smaller rooms opening out of it, but with separate entrances from outside. One of these was used as a depôt for vessels containing the dredged stuff in sea-water waiting examination, while the smaller was used as a workroom when the other tables were occupied. We had all brought our own microscopes, preserving fluids, books, &c., so that for practical purposes we had a really excellent Biological Station. I was forcibly struck by the great advantages of the combination of such a temporary station with the co-operation which exists when several biologists work at it on different

groups of animals or plants; for, as each haul of the dredge or tow-net brings up material for each worker, it is easy for everyone, after he has picked out his own beasts from a quantity of weed, &c., to pass it on to his next neighbour, who takes out his, and again passes it on. This ensures a thorough overhauling of all material, and it frequently happened that after I had picked out, as I thought, all the Amphipoda, Mr. Gamble, to whom I passed it for Nudibranchs, Planarians, &c., would find two or three more.

Thanks to a grant from the Royal Society, we had a sailing trawler of about 30 tons at our disposal, but it must be confessed that she was not as useful as could have been wished. There was generally either too little wind or too much, and in the latter case the huge Atlantic rollers made dredging almost, if not quite, impossible. However, a few excursions were made in her, and were not without results, but we never got into more than 40 or 50 fathoms depth. In the harbour we could always dredge, but there is nowhere more than 9 fathoms. The bottom is very variable, generally rocky, with much Laminaria, but in some places sandy. South of the Ferry Pier there is a bed of very fine, soft mud in 1½ fathoms, which I found very productive of Crustacea when worked with the rake and tow-net. This apparatus, which consists of a muslin or cheese-cloth tow-net attached to a weighted iron rake, was found most successful in taking not only free-swimming animals at the bottom, but also Nudibranchs, &c. In working the mud it was necessary to attach the tow-net so as to be 4 or 5 feet behind the rake, and even then it filled in a few minutes. The contents (mostly mud) were then emptied into a bucket which was taken to the laboratory, where it was left to stand. As the mud settled the Crustacea worked their way

up to the supernatant water, and were taken by pouring it through muslin. In this manner I procured, among other species, several specimens of *Phoxocephalus pectinatus*, Walker.

In his Presidential Address to Section D of the British Association at Ipswich (Rep. B. A., 1895, p. 702), Dr. Herdman expressed his dissent from Dr. John Murray's opinion that a greater number of species of marine animals is to be found in the mud at a depth of about 100 fathoms than at lesser depths. Dr. Herdman's examples to prove the contrary were from hauls on various, but chiefly sandy or stony, bottoms. It has struck me that Dr. Murray might fairly object to the hauls in shallower waters on bottoms other than *fine* mud (as it usually is, I believe, at 100 fathoms) being compared with his captures on such ground; and as the mud south of Valentia pier was very fine mud, free from sand, I offer the following figures as showing the difference in the number of species taken there and in equally fine mud at about 45 fathoms between the Isle of Man and Ireland. It is, however, quite possible that the composition of the two muds is different.

1. 45 fathoms, 7 miles west of Niarbyl, July 8th, 1894. Steamer "John Fell." Large dredge with tow-net attached to bag, and small brass dredge with cheese-cloth bag. Duration of haul probably one hour.

Crustacea taken—

Podophthalmata (Gonoplax and Calocaris)	2 sp.
Amphipoda	1 ,,

2. 1½ fathoms, S.S.E. of Valentia pier, August 26th, 1896. Tow-net attached to iron rake. Two hauls about ten minutes each.

Crustacea taken—

Schizopoda	5 sp.
Cumacea	3 ,,
Isopoda (Leptochelia)	1 ,,
Amphipoda	12 ,,
Caprellida	2 ,,
Total Malacostraca	23 ,,

In addition to the species taken at Valentia, the annexed list contains a number belonging to the collection in the Dublin Museum of Science and Art, which were submitted to me by Dr. Scharff to be named. Two of the species are new to science, viz., *Apseudes hibernicus*, a cheliferous Isopod, and *Parapleustes megacheir*, a very distinct and interesting Amphipod, dredged in 750 fathoms. I have described these in the Journal of Proceedings of the Linn. Soc., vol. XXVI., p. 226, pl. 18. Other interesting species, as being hitherto unrecorded in British seas, are—*Janiropsis breviremis*, G. O. Sars; *Eurydice elegantula*, Hansen; *Ambasia danielsseni*, Boeck; *Parvipalpus capillacea* (Chevreux).

The total figures of each order are as follows:—

Podophthalmata	13 sp.
Schizopoda	14 ,,
Cumacea	7 ,,
Isopoda	17 ,,
Amphipoda	85 ,,
	136 ,,

INDEX TO STATIONS (Valentia).

V.=Valentia.

V.H.=Valentia Harbour.

D.M.=Dublin Museum.

F.W.G.=F. W. Gamble } collected by
E.T.B.=E. T. Browne }

R.D.S.=Royal Dublin Society.

R.I.A.=Royal Irish Academy.

St. 1. Two miles N.W. of N. entrance of harbour, 20 f., 22/8/96.

St. 2. Harbour between Cruppaun Point and Glanlean Bay, 3-9 f., 22/8/96. Laminaria, &c.

St. 3. Port Magee entrance E. of Bray Head, 15 f., 24th. Shelly sand.

St. 4. South of Port Magee, 4-5 f., 24th. Laminaria, &c.

St. 5. South-east of Ferry Pier, 1½ f., 26th. Soft mud.

St. 6. Lough Kay, 2-4½ f., 27th. Laminaria, &c.

St. 7. Outside a line between Bray Head and Puffin Island, 40 f., (?) 28th. Gravel.

St. 8. N.W. of N. entrance of harbout, 36 f., 28th. Sand

CRUSTACEA collected at Valentia, August, 1896, and from Dublin Museum of Science and Art :—

PODOPHTHALMATA.

Inachus dorsettensis (Penn). St. 8.

I. dorynchus, Leach. St. 6.

Ebalia Cranchii, Leach. St. 8.

Anapagurus hyndmanni (Thompson). St. 7, 8.

Galathea intermedia, Lilljeborg. St. 6, 7.

Leucifer typus (Vaughan Thompson). V.H., tow-net, E.T.B., larva.

Crangon trispinosus, Hailstone. St. 3, 6.

C. neglectus, Sars. St. 3.

Nika edulis, Risso. St. 2.

Hippolyte varians, Leach. V.H., common.

Spirontocaris cranchii, Leach. V.H., St. 2.

Pandalus brevirostris, Rathke. St. 1, 7.
Leander serratus, (Pennant). St. 6, shore.

Schizopoda.

Lophogaster typicus, M. Sars. St. 7.
Nyctiphanes norvegica, (M. Sars). V.H., tow-net, E.T.B.
Macromysis flexuosus, (Müller). V.H., tow-net (E.T.B.).
M. neglecta (Sars). St. 2, 4, 5, 6.
M. inermis (Rathke). St. 2, 4, 6.
Schistomysis ornata (Sars). St. 3.
Heteromysis formosa, S. J. Smith. V.H., shore.
Leptomysis lingvura, Sars. St. 1, 6, Dingle Bay (F.W.G.).
Mysidopsis gibbosa, Sars. St. 5, 3.
M. angusta, Sars. St. 5.
Erythrops serrata, Sars. W. coast of Ireland, off the Skelligs, 52-62 f., 20/8/90 (D.M.).
Siriella armata, (M. Edw.). St. 2, 4, 5, 6, V.H., tow-net, E.T.B.
S. clausii, Sars. St. 5.
Gastrosaccus spinifer (Goes.). St. 3.

Cumacea.

Cuma scorpioides (Montagu). St. 4.
Iphinoë trispinosa (Goodsir). St. 6.
Eudorella truncatula (Sp. Bate). St. 5.
Cumella pygmœa, Sars. St. 5.
Pseudocuma longicornis, Sp. Bate. St. 3.
Diastylis biplicata, Sars. St. 7.
D. rugosa, Sars. St. 5.

Isopoda.

Apseudes hibernicus, A. O. Walker (Jour. Linn. Soc., vol. XXVI., Zoology, p. 226, pl. 17-18). Church Island, V.H., shore, 1 specimen; W. coast of Ireland, D.M., 2 specimens.

Typhlotanias sp. V.H. (F.W.G.).

Leptochelia dubia (Kröyer). St. 5.

Cirolana borealis, Lillje. 28 m. N.W. of Achill Head on long lines, R.D.S. Fish. Survey, 154 f., 20/4/91; Bantry Bay, Kenmare R., on Picked Dog-fish, W. coast of Ireland; Baltimore, Co. Cork, Rev. Davis, Dec., 1889; off Bull Rock, 21/1/91; from stomach of Skate, 53 f., St. 12, 21/6/90 (all D.M.).

Conilera cylindracea (Montagu). Bantry Bay, 1896 (A.R.C.N., D.M).

Eurydice achata (Slabber) = *E. pulchra*, Leach. Kingston Harbour, Aug., 1883 (D.M.).

E. elegantula, (Hansen). Outer Harbour, Killiebegs, Co. Donegal, 14-16 f., R.D.S. Exp. (D.M.).

Sphæroma serratum (Fabr.). Bantry Bay, 1896 (D.M.); Malahide Estuary (D.M.).

Dynamene rubra (Mont.) = *Næsa bidentata* (Adams). ♂ V.H., shore, Sherkin Island, Co. Cork (A.R.N., 1895, D.M.), Dalkey (A.C.H., D.M.).

Astacilla longicornis (Sowerby) = *A. gracilis* (Goodsir). ♂ Bantry Bay, 1893 (D.M.); V.H. (F.W.G.); off Bull Rock, S.W. Ireland (D.M.).

A. intermedia (Goodsir). Bantry Bay, 30 f., 1892 (D.M.).

Idotea linearis (Linné). Generally distributed.

I. emarginata (Fabr.) Bantry Bay (D.M.); V.H.; Roundstone, Co. Galway (D.M.); S.W. Ireland, R.I.A. Exp., 1888, 6 f.; Blacksod Bay (?), "From Oarweed," Killeany Bay, 3 f., 5/6/90.

I. marina (Linn.) = *I. balthica* (Pallas). Generally distributed.

I. granulosa, Rathke = *I. phosphorea*, Harger. Bray (A.R.N.), V.H. (A.C.H., D.M.), Dungarvan (A.R.N., 1896, D.M.), Dalkey (A.C.H.).

I. viridis (Slabber). V.H., shore.

Janira maculosa, Leach. St. 4.

Janiropsis breviremis, G. O. Sars. V.H., shore.

AMPHIPODA.

Hyperia galba (Mont.). V.H. (F.W.G.) from Pelagia.

Parathemisto oblivia (Kröyer). V.H., Dingle Bay, &c., young, abundant, no adult.

Phronima sedentaria, Forskäl. S.W. of Ireland, Rev. W. S. Green, Aug., 1890 (D.M.).

Orchestia littorea (Mont.) Portmarnock, Nov., 1893 (D.M.); Bantry Bay, 1892 (D.M.); Mornington, Co. Meath, Scharff, June, 1894 (D.M.); Malahide Estuary.

Hyale nilssonii (Rathke). V.H., shore.

Lysianax ceratinus, A. O. Walker (Proc. L'pool Biol. Soc., 1889, Vol. III., p. 200, pl. 10, figs. 1-8. St. 2, 6, 7.

L. costæ (M. Edw.) St. 5.

Socarnes erythrophthalmus, Robertson. V.H. (F.W.G.).

Ambasia danielsseni, Boeck. S.W. Ireland, 750 f., R.I.A. Exp., 1888 (D.M.).

Callisoma kröyerii (Bruzelius). W. coast of Ireland, off the Skelligs, 52-62 f., 20/8/90 (D.M.); off Ballycotton, 30 f., R.D.S., 28/8/90 (D.M.).

Hippomedon denticulatus (Sp. Bate). St. 7.

Orchomenella nana (Kröyer). St. 2.

Tryphosites longipes (Bate). W. coast of Ireland, off the Skelligs, 52-62 f., 20/8/90 (D.M.); off Bull Rock, S.W. Ireland, R.D.S. (D.M.).

Hoplonyx cicada (Fabr.). 45 m. N.N.W. of Blacksod Bay, 250 f., May, 1891, R.D.S. Fish. Exp. (D.M.); W. coast of Ireland, long lines, 28 m. N.W. of Achill Head, 154 f. (D.M.); Kenmare River, 26 f., 28/3/91, R.D.S. Fish. Survey (D.M.).

Lepidepecreum carinatum, Bate. St. 3, off Teelin, Co. Donegal, 33-37 f., R.D.S. Fish. Exp., 19/5/91.

Urothoe brevicornis, Bate; Church Island, shore, ♀ with ova; V.H. (F.W.G.).

U. elegans, Bate. Surface, Blacksod Bay, R.D.S. survey of fishing grounds, 7/7/90.

Phoxocephalus pectinatus, A. O. Walker = *P. simplex*, Calman, nec Sp. Bate. St. 5.

Ampelisca tenuicornis, Lillje. St. 5, 6.

A. brevicornis (Costa) = *A. lævigata*, Lillje. V.H. (F.W.G.), Dunbeacon Harbour (D.M.).

A. spinipes, Boeck. St. 7, Dingle Bay (F.W.G.), off Gt. Skellig, 70-80 f., R.I.A. Exp., 1886 and 1888 (D.M.).

A. macrocephala, Lillje. Off Bull Rock, S.W. Ireland, 21/3/91, R.D.S. (D.M.).

Stegocephaloides christianiensis (Boeck). West coast of Ireland, off the Skelligs, 52-62 f., 20/8/90 (D.M.); S.W. Ireland, 750 f., R.I.A. Exp., 1888 (D.M.).

Gitana sarsii, Boeck. St. 5.

Cyproidea brevirostris, T. and A. Scott. St. 1.

Stenothoë marina (Bate). St. 7.

S. monoculoides (Mont.). St. 1, 2, 5. V.H., shore, common. Generally has a dark band across the back, which disappears in Formaline.

Leucothoë spinicarpa (Abildgaard). St. 2.

Monoculodes carinatus, Bate. St. 3, 7, off Bull Rock, S.W. Ireland, 21/3/91, R.D.S. (D.M.).

Perioculodes longimanus (Bate). St. 2, 6.

Synchelidium haplocheles (Grube). St. 6, 7.

Halimedon parvimanus (Bate). St. 1, 7, off the Skelligs, 52-62 f., 20/8/90, R.D.S. Fish. Exp. (D.M.); W. of Arran Island, 44-46 f., 7/4/91, R.D.S. Fish. Exp. (D.M.); off Bull Rock, S.W. Ireland.

Parapleustes latipes (M. Sars). Dunmanus Bay, 1892 (D.M); Bantry Bay, 1892 (D.M.); S.W. Ireland, R.I.A. Exp., 1888, log. 72 (D.M.).

Parapleustes megacheir, A. O. Walker. (Jour. Linn. Soc., Zool., vol. XXVI., p. 230, pl. 18.) S.W. Ireland, 750 f., R.I.A. Exp., 1888, log. 69 (D.M.), 3 specimens.

Epimeria cornigera (Fabr.). W. coast of Ireland, off the Skelligs, 20/8/90, 52-62 f. (D.M.); off Bull Rock, S.W. Ireland (D.M.); Bantry Bay, 1892 (D.M.); off Ballycotton, R.D.S., 28/8/90 (D.M.).

Iphimedia obesa, Rathke. 53 m. W.S.W. of Dersey Head, R.I.A. Exp., 1886, 325 f. (D.M.).

I. minuta, Sars. St. 2, 4; Dunbeacon Harbour, 2½ f. (D.M.), colour bright yellow; S.W. Ireland, R.I.A. Exp., 1888, 6 f.

Eusirus longipes, Boeck. Off Bull Rock, S.W. Ireland, 21/3/91, R.D.S. (D.M.).

Apherusa borealis, (Boeck). V.H. shore, 26/8/96, colour bright red.

A. bispinosa (Bate). St. 3, 4, tow-net, E.T.B.

A. Jurinii (M. Edw.). V.H., shore and tow-net, E.T.B., St. 5, 6.

Paratylus swammerdamii (M. Edw.). St. 4, 6, off Port Stewart (D.M.).

P. uncinatus (Sars). St. 3.

P. vedlomensis (Bate). St. 4, 7.

Dexamine spinosa (Mont.). St. 2, 4. 5; Dunbeacon Harbour, 2½ f. (D.M. 103, 1892); Long Island, (D.M.), &c.

Tritœta gibbosa (Bate). V.H., shore.

Guernea coalita, Norman. St. 7.

Melphidippella macera, Norman. St. 1, W. of Arran Island, 44—46 f., 7/4/91, R.D.S, Fish. Exp. (D.M.).

Amathilla homari (Fabr.). V.H., shore and tow-net, E.T.B.

Gammarus marinus, Leach. Glengariff (Scharff, D.M.); Sherkin Island, shore (D.M.).

G. locusta (Linn.). St. 6, Dunbeacon Harbour (D.M.), generally abundant.

G. campylops, Leach. St. 7, Bray, A.R.N., 1896 (D.M.).

G. duebeni, Lilljeborg. Lough Doon, Co. Kerry (D.M.); N.W. Lough Corrib, A.R.N. (D.M.).

Gammarella brevicaudata (M. Edw.). St. 4.

Melita palmata (Mont.). V.H., shore; St. 5.

M. Obtusata (Mont.). W. coast of Ireland, off the Skelligs, 52—62 f., 20/8/90 (D.M.).

Mœra othonis, M. Edw.=*M. semi-serrata* (Sp. Bate). St. 4.

Megaluropus agilis, Norman. St. 6.

Cheirocratus sundevalli (Rathke). St. 5, 7.

C. assimilis (Lillje.). St. 4.

Aora gracilis, Sp. Bate. St. 2, 4; Dunbeacon Harbour, 2½ f. (D.M.).

Microdeutopus anomalus (Rathke). W. coast of Ireland (D.M., 64, 1896).

M. damnoniensis (Bate). St. 5.

Lembos websterii, Bate. Dunbeacon Harbour (D.M.).

L. longipes (Lillje.). St. 1, 2.

Leptocheirus pilosus, Zaddach nec Sars. St. 7, W. coast of Ireland (D.M., 64, 1896); Baltimore, Co. Cork (D.M.).

Gammaropsis maculatus (Johnston)=*G. erythrophthalma*, Lillje. St. 6, var.

Megamphopus cornutus, Norman. St. 7.

Microprotopus maculatus, Norman. St. 5.

Photis longicaudatus (Bate). V.H. (F.W.G.).

Amphithoe rubricata (Mont). V.H., shore; W. coast of Ireland, off the Skelligs, 52—62 f., 20/8/90 (D.M.)

Pleonexes gammaroides, Bate. V.H., shore; St. 7; Dungarvan, 1896, A.R.N. (D.M.).

Ischyrocerus minutus, Lillje. V.H., tow-net, E.T.B.; Dalkey, A. C. Haddon (D.M.).

Podocerus falcatus (Mont.). V.H., shore, St. 6; Dalkey, A.C.H. (D.M.).

P. cumbrensis, Stabbing and Robertson. St. 3.

Erichthonius abditus (Templeton). St. 2, 3.

Siphonœcetes colletti, Boeck. Dalkey, A.C.H. (D.M.).

Corophium grossipes (Linn.). Ballyshannon, 1895 (D.M.).

C. bonellii, M. Edw. St. 2, 5; V.H., shore.

Phtisica marina, Slabber. St. 2, 5, 6; Dunbeacon Harbour (D.M.); Long Island (D.M.), 5 f.; Dunmanus Bay.

Caprella acanthifera, Leach. St. 2, 5, 6; Dalkey, Co. Dublin, A.C.H., var. (D.M.).

C. linearis. Long Island, 5 f.; Dalkey, A.C.H. (D.M.).

C. acutifrons, Latreille. St. 6.

Parvipalpus capillacea (Chevreux). St. 1.

Notes on Irish Crustacea.

Eurydice elegantula, Hansen.

This species differs from *E. achatina* (Slabber) [*E. pulchra*, Leach] in the square truncation of the telson. From *E. truncata* (Norman) and *E. spinigera*, Hansen, it appears to differ in the greater breadth of the straight posterior margin of the telson, and by this being bounded at each extremity by a single small tooth. I am not aware that it has ever been recorded before from the shallow water of the British area, the localities given by Hansen being from the Atlantic to the W. of Scotland, in lat. 56°-60° N., long. 13°-18° W.

Leptochelia dubia (Kröyer).

This does not appear to have been previously recorded from the British area. According to G. O. Sars ("Middel-

havets Saxisopoder," p. 317) it occurs in the Mediterranean and on the coasts of New England and S. America.

Idotea granulosa, Rathke.

It appears to me that *I. phosphorea*, Harger, ought to be referred to this species.

Janiropsis breviremis (Sars), 1 ♀ with ova, length 2.75 mm.

Not previously recorded out of Norway. In Sars' figure (" Crust. of Norway," vol. II., pl. 42) of the dorsal view of the female the legs are much too small.

Lysianax ceratinus, A. O. Walker.

I have to thank Mons. E. Chevreux for pointing out that this species, which I had thought to be too close to *L. longicornis* (Lucas) to be separated from it, is distinct. The almost entire absence, in *L. ceratinus*, of the long tooth on the lower distal margin of the first joint of the upper antennæ, which is so characteristic of *L. longicornis*, is the most obvious difference. According to M. Chevreux the latter species is exclusively Mediterranean, while *L. ceratinus* is found both in that sea, in the Channel Islands, and on the west coasts of England and Ireland. It must, therefore, be understood that wherever I have recorded *L. longicornis*, *L. ceratinus* is the species intended.

Ambasia danielsseni, Boeck.

This species has not been previously recorded out of Norway, where it is found at 40-100 fath. (Sars, "Amphipoda of Norway," p. 46). It would appear, therefore, to be found at greater depths when further south, the specimen examined having been dredged in 750 faths.

Ampelisca tenuicornis, Lillje.

The specimens taken at Valentia had the hind margin of the first joint of the last perœopods rounded and notched. This may, however, be only a condition of immaturity, as none were adult.

Ampelisca spinipes, Boeck.

The four specimens taken at St. 7 had the fourth joint of the sixth perœopods less spinous than in the typical form.

Corophium bonellii, M. Edw.

The male of this species is very rare, though females are abundant. It was not known to Prof. G. O. Sars when he published his "Amphipoda of Norway." I have taken one or two on the Welsh coast among a large number of females. The most obvious differences between it and *C. crassicorne* ♂ are as follows:—

	C. crassicorne. ♂	*C. bonellii.* ♂
Upper antennæ—	1st joint with *5 or 6* spines on lower margin, *the 2 proximal reflexed.*	1st joint with *3* spines on lower margin directed forward.
Lower antennæ—	Last joint of peduncle *with* a tooth on the inner margin near the proximal end.	Last joint of peduncle *without* a tooth on the inner margin.

OCCURRENCE in GREAT ABUNDANCE of CREPIS TARAXACIFOLIA, Thuill., at COLWYN BAY, DENBIGHSHIRE.

By Alfred O. Walker, F.L.S.

[Read Dec. 10th, 1897.]

In the early summer of 1895 Dr. Russell, of Colwyn Bay, and I both noticed a few examples of the above plant in Nant-y-Glyn Valley. It is a conspicuous plant, and as Dr. Russell had been studying the flowering plants of the neighbourhood for two or three years, it is not likely that he would have overlooked it had it been there. I have also kept a look-out for any unusual flowering plants, yet neither of us had seen it before. In the summer of 1896 the plant became abundant in my fields, both pasture and arable, which are on a steep slope of Wenlock Shale, facing S.E., and therefore very dry. In June, 1897, it had become by far the most conspicuous weed in my fields, giving a brilliant golden colour to a whole patch of newly-sown clover and grass, and to a great part of an old meadow.

I saw it also in abundance in other places in the neighbourhood, *e.g.*, on the road side by the Marine Hotel, Old Colwyn, and at the top of Penmaen Hill, on the Limestone, in the Llysfaen township. Dr. Russell also noticed it independently in these localities,* and in a field below the Queen's Hotel, Old Colwyn, which, as in the case of my fields, was coloured bright yellow by it.

Crepis taraxacifolia has hitherto been considered a rare plant. H. C. Watson (1849) only records it in Kent,

* Dr. Russell tells me that he first noticed it on Penmaen Hill in 1894.

Surrey, and (on the authority of C. C. Babington) Carnarvonshire. He subsequently, in the "Compendium," (1870) added the Eastern Counties. Babington (1856) simply gives "Limestone districts" as its habitat, which they certainly are not exclusively. Sir J. D. Hooker ("Students' Flora," 1878) gives "dry banks and chalky pastures in S.E. England, local, from Yorkshire to Surrey and Devon, and in Carnarvon. Finally, Mr. J. E. Griffith, in his excellent "Flora of Anglesea and Carnarvon," published 1895,* calls it "rare and local," and gives only one locality for it (at Bangor), where, however, it seems to occur "plentifully." It would therefore appear that though known to occur in Carnarvonshire nearly, if not quite, fifty years ago, it remained "rare and local" down to two years ago, while in Denbighshire it has suddenly become a weed so abundant that were it not fortunately not distasteful to cattle, it would be a very serious nuisance to farmers. As it is an annual, and generally seeds before the hay crop is ready to cut, it is not easy to see how it can be destroyed, but in all probability it will soon disappear from the effect of adverse climatic influences.

The only possible cause that I can suggest for the sudden appearance of the plant in the neighbourhood of Colwyn Bay is that, in the three years 1895—97, the month of May has been exceptionally dry, the rainfalls having been respectively 0·46 in., 0·39 in., and 0·99 in. The average rainfall for this month for the fifteen years before 1895 is 2·26 in. These figures are from my own recorded observations.

Mr. F. W. Moore, A.L.S., Director of the Royal

* Mr. Griffith informs me (Nov. 24th, 1897) that he has still "never seen *C. taraxacifolia* except in one field near Bangor," though it has increased there and spread into the next field.

Botanic Gardens, Glasnevin, Dublin, has mentioned a similar increase in this plant in County Wicklow, in his Report as Consulting Botanist to the Royal Dublin Society for 1896. He also informs me that in the introduction to Moore and More's "Cybele Hibernica," p. 25, this plant is given in a list of the twenty-four scarcest British plants occurring in Ireland.

The influence of comparatively small and even temporary variations of climate on plant and animal life and distribution has not received the attention it deserves. It is scarcely necessary to point out that there is a better chance of the occurrence of a variety fitted to withstand adverse climatic influences in a large number of individuals than in a small, so that, in the case before us, the three favourable years may result in the plant becoming, at all events comparatively, common.

Report on the Investigations carried on in 1897 in connection with the Lancashire Sea-Fisheries Laboratory at University College, Liverpool, and the Sea-Fish Hatchery at Piel, near Barrow.

Drawn up by Professor W. A. Herdman, F.R.S., Honorary Director of the Scientific Work; Assisted by Mr. Andrew Scott, Resident Fisheries Assistant at Piel, and Mr. James Johnstone, Fisheries Assistant at Liverpool.

CONTENTS:—

Introduction.

During the earlier part of the year a good deal of Mr. Scott's time was occupied in helping Mr. Dawson and myself in preparing for the course of Sea-Fisheries lectures, which was delivered in January, February, and March in Liverpool. After that Mr. Scott was sent to make some hatching experiments at Piel, and then had to suddenly leave all the usual laboratory work and devote most of his time to the preparation of the rather elaborate exhibit which the Lancashire Sea-Fisheries Committee sent to the Jubilee Exhibition at the Imperial Institute, and which will be found fully described further on in this Report. During this busy time one of the College Laboratory lads, Mr. Tom Mercer, had to be drafted into

the fisheries work to help Mr. Scott and myself. It was soon found that we could usefully employ the whole of Mercer's time in this way, and later in the year he was definitely taken over into the Committee's service. During most of the summer and autumn he worked under Mr. Scott in arranging the Fisheries Exhibition in Liverpool, and since October he has acted as attendant in charge of that exhibition, and in doing any other work required in connection with the collections, and helping generally in the Fisheries Laboratory.

Mr. Scott went into residence at the Piel Hatchery on December 1st, and his place in the Liverpool Fisheries Laboratory has been filled by the appointment of Mr. James Johnstone, from the Royal College of Science, South Kensington, who entered upon his duties early in the present month (January, 1898).

The course of Sea-Fisheries lectures delivered in Liverpool last spring by Mr. Dawson, Mr. Ascroft, Mr. Scott, Mr. Thompson, Professor Boyce, and myself went off successfully, and attracted a good deal of interest. Alderman Grindley attended the last lecture, and at the conclusion of the course spoke in the name of the Lancashire Sea-Fisheries Committee. The hope was expressed by some of the audience and by the Press that the course would be repeated in other parts of the district, and that further lectures would be given in Liverpool. Our Exhibition and Fisheries Collections at the College now give us means of illustrating fishery courses, or of arranging demonstrations on fishery subjects, such as can exist in very few, if any, other centres in the country.

In January 1896, at the end of the Introduction to the Report for 1895, in urging the formation of the Fisheries Museum, which we now have, I pointed out that such collections, showing the work we were doing and the

results we had arrived at, formed "the practical evidence that Fisheries Experts from abroad especially desire to see when they come for information in regard to local fisheries and the conditions under which they are carried on." A year after that, last February, I am glad to say we had a visit from Dr. P. P. C. Hoek, Fisheries Scientific Adviser in Holland, who was sent by his government to confer with Prof. Boyce and myself as to our work on diseased conditions of Oysters, and to see our specimens and methods of investigation. Dr. Hoek stayed for some time working in our laboratories, and was pleased to express the opinion that he had thereby been saved a good deal of valuable time by getting as rapidly as possible into touch with the details of our work, so as to be able to carry on investigations in Holland on similar lines. We have also had an interesting visit from Dr. Johan Hjort, Scientific Adviser on Fisheries to the Norwegian government. We have had some correspondence with Dr. Hjort since, and the Committee has been able to help him in his work by sending him a shank trawl such as we think will be best suited for the local conditions off the south coast of Norway, where, at depths of over 60 fathoms Dr. Hjort has found considerable quanties of *Pandalus borealis*, a large prawn, which he thinks might be profitably fished.

During the summer I went to America, and took the opportunity of seeing all I could of various kinds of Fisheries Institutions, and of talking to fisheries authorities both in Canada and the United States. I visited hatcheries on the east coast of Canada, saw the enormous numbers of salmon in the rivers of British Columbia on the west coast, and also met Prof. Prince, the Commissioner of Fisheries for the Dominion, as well as other Canadian scientific men.

In the States I visited the head-quarters of the Fish Commission at Washington, and had the advantage of discussing their operations with a number of members of the staff. I then went to the celebrated hatchery at Wood's Holl, where I spent a couple of days with the Superintendent of the Hatchery, with the Collector (Mr. Vinal Edwards), and the Captain of the "Grampus," learning all I could of the details of their work, both as to sea-fish eggs and as to lobsters. Lastly, I went to Gloucester, the chief centre of the fishing industries of the American coast, and said to be the greatest fishing port in the world. There is a sea-fish hatchery here also, belonging to the Fish Commission, which has just recently been enlarged in order to increase the output. At both these hatcheries I saw the working of the McDonald hatching jar for lobster eggs, which we propose to try experimentally at Piel. It was interesting to learn at Gloucester that when the Fish Commission proposed lately to remove the hatchery from there to another part of the coast, the fishermen objected to the removal from their midst of what they regarded as a valuable institution.

Many of the details of information which I was able to learn on this tour of inspection will, I have no doubt, be of use in our local operations, and some of these points will be alluded to later on in this Report.

The chief additional matters I have to report upon this year are:—

1st.—A scheme which we started a year ago for the simultaneous observation of the "plankton," or floating fish food, &c., in the sea round our district, taken weekly throughout the year, at half a dozen stations. We are continuing the observations this year on an improved plan.

2nd.—The experimental sea-fish hatching carried on last Easter by Mr. Scott at Piel and by myself at Port Erin; and in that connection the possibility of effecting some union for fishery purposes with the local authorities at the Isle of Man. I have pointed out in previous Reports the community of interests in the case of the Lancashire and the Manx sea areas. A Commission is now sitting, under the chairmanship of the Bishop of Sodor and Man, to consider and report upon the insular industries, and the first industry they are dealing with is the fisheries. This seems, then, to be an opportunity—which would be welcomed, I believe, by those concerned in the Isle of Man—for carrying out some joint arrangement whereby young fish should be equally and efficiently protected on both shores, shell-fish and lobster culture be encouraged and regulated, and sea-fish hatcheries be established.

3rd.—The continuation of the work by Prof. Boyce and myself upon diseased conditions in Oysters and other shell-fish (see below, p. 26). It is interesting in this connection to note that the whole of my last year's account of this subject, amounting to about twenty pages of our Fisheries Laboratory Report, has been translated and printed by the French Fisheries authorities in the "Bulletin des Pêches Maritimes" for August, p. 273, under the title of "Recherches sur les Huitres."

In addition to the work recorded in this Report, during the year several samples of sewage and other effluents discharging from pipes into our estuaries have been examined by my assistants, and I have given my opinion to the Committee as to whether or not, under all the circumstances, these discharges could be considered as injurious to the fisheries of the neighbourhood.

I have also prepared, at the request of the Chairman, an outline scheme of work to be undertaken at Piel (see below, p. 9.), and a Memorandum on Technical Instruction for Fishermen, from which I quote the following opinion:—

"Instead of sending lecturers to various parts of the district, it would be better to bring parties of selected men from the different fishing centres to Liverpool to hear some fishery lectures in the University, where there are facilities for effective illustration, and to be shown matters practically in the Fisheries Laboratory and in the Museum. I should recommend, also, that these same men should be sent afterwards in the same way to our Marine Hatchery at Piel *during the hatching season.*"

It has been suggested that a useful addition to our investigation during the last two years of the currents of the Irish Sea by means of drift bottles would be the liberation of large numbers of drift bottles at the spots where we find fish spawn. We propose to use empty wine bottles weighted with sand so as to float submerged, with our usual post-card attached to the inner end of the cork. The bottles are now being prepared, and will be set free from the steamer during the spawning season.

I append to this Report:—

(A.) A note on the Shad, by Mr. R. L. Ascroft.

(B.) A guide to the very successful Sea-Fisheries Exhibition at University College, which was opened by Mr. John Fell on October 29th.

W. A. Herdman.

January, 1898.

THE HATCHERY AND LABORATORY AT PIEL.

AT the end of last year's Report, brief reference was made to the establishment of a Sea-Fish Hatchery and Station for experimental work at Roa Island, known to the post-office as Piel, in the Barrow Channel, and about five miles from Barrow. Piel is now connected with the mainland by a railway embankment, and there are several trains in the day, each way, from Barrow. The "Villa Marina" (appropriate name) has been secured by lease from the Furness Railway Co., by the Sea-Fisheries Committee, and has been modified and adapted to the new purposes—fisheries investigation and experiment—under the direction of the Scientific Sub-Committee. Two rooms and a passage on the ground floor have been thrown together to form a large, well-lighted laboratory, 36 by over 20 feet, capable of affording comfortable working space for six students or investigators. The former lifeboat house, measuring 44 by over 16 feet, has been connected with a room opening from the kitchen, and has been fitted up with aquaria and hatching tanks. It will be referred to in future as the tank-house: it is well lighted by both side windows and sky-lights.

The rest of the house gives plenty of accommodation both for additional laboratories, if needed in the future, and for residential requirements. In addition to the kitchens and pantries, there are two public rooms, the dining-room and the library, a photographic dark-room, and three or four bed-rooms for the working naturalists. Two rooms upstairs have been handed over to the resident Scientific Assistant, Mr. Andrew Scott, and two to the resident bailiff, Mr. H. Richardson. Other rooms remain unfurnished, available for such purposes as may seem best as requirements develop.

The laboratory has 8 windows, on its N., E., and S. sides, and is fitted with both fixed and movable work tables, with wall shelving, cupboards, sets of drawers, sinks, gas, and both fresh and sea water. It is not proposed to have any fixed tanks in the laboratory. Small movable aquaria can be accommodated, but larger ones are confined to the tank-house. Apparatus and reagents are provided.

The tank-house has two large storage cisterns in the loft, capable of containing over 5,000 gallons of sea water. These are filled by a supply pipe from a 3-horse power Crossley gas engine and pump, which draws the water from a carefully chosen spot on the beach. Pumping can be carried on for about 4 hours during an ordinary tide, and the pumps are capable of supplying 2,500 gallons per hour. From the cisterns the water is led to the filter, where it passes upwards through 3 folds of thick blanket, and then to the concrete and plate-glass wall tanks, of which there are four, measuring respectively 11 by 3 by 3 feet, 7½ by 3 by 6 feet, 4 by 3 by 3 feet, and 3½ by 3 by 1½ feet.

There are also several floor tanks of concrete, of large size, which will be suitable for Lobsters and other shell-fish. The wooden hatching tanks were made in Liverpool, and are exactly like those described and figured in our last Report. They measure each 5 by 2½ by 1½ feet. These, and the various smaller wooden tanks and glass aquaria are movable. We have also several of the American McDonald hatching jars, which will be used for Lobster eggs.

Sometime ago, at the request of the Scientific Sub-Committee, I prepared a statement of the work which I proposed should be carried on at Piel. This was adopted by the Committee, and I now reprint it here in order that it may be placed on permanent record.

"MEMORANDUM sent to the Chairman of the Lancashire Sea-Fisheries Committee, for the use of the Scientific Sub-Committee, by Prof. W. A. Herdman, in October, 1897, on an

"OUTLINE SCHEME OF WORK FOR THE PIEL SEA-FISH HATCHERY.

"I think that the Institution at Piel, although it may serve several useful purposes, ought to be regarded as primarily for the hatching of sea-fish and Lobster eggs, and for experiments upon the further rearing of young sea-fish and upon the life history of shell-fish. That is, the ECONOMIC work ought to be regarded as of first-rate importance, and nothing else ought to be allowed to interfere with it. Mr. Scott ought to be instructed to give his whole attention to making the hatching and rearing a success. In my visit to America this summer, I made a careful study of the methods of the United States Fish Commission, at their two celebrated Hatcheries, at Woods Holl and at Gloucester. In each case the Institution is under the charge of a resident "Superintendent," who gives his whole time and attention to making the hatching and rearing a practical success. These men try to perfect every little detail of the cheese cloth in the hatching boxes, of the jets of water, of the cleansing of the boxes, the removal of dead ova, of the distribution of the fry, and so on—the little details upon which the economic results depend. Research and teaching are left entirely in other hands, and are carried on for the most part in other Institutions, such as the Biological Laboratory at Woods Holl and the Central Institution in Washington.

"I would propose, however, that the Piel Hatchery be

used secondarily, and so as not to interfere with the primary object, for two other purposes, viz. :—

"1st—For teaching the *practical details* of hatching and rearing to selected fishermen from different parts of the district, who might be brought in small parties at the proper season and have their expenses paid. A visit to Piel would probably be much more instructive after one had heard a lecture or two on the eggs, reproduction, fertilization, and development of fishes; and, as all others matters connected with the fisheries can be much more efficiently and conveniently taught at University College, Liverpool, where there are the laboratories and collections, it would be better for such fishermen to visit Piel after attending a course at Liverpool. The Piel Institution ought also to be available for the instruction in practical hatching of an occasional young man who is training himself with the view of filling some fishery post, such as superintendent of a district, or Scientific Fisheries Assistant in charge of a hatchery. Such a man ought first to go, as a student, through a regular course of zoology at a University laboratory, and then a prolonged visit to Piel during a hatching season, ought to be of the greatest benefit to him.

"2nd.—The other object which I should like to see fostered at Piel, so far as is compatible with the hatching work, is the encouragement of research by independent biologists, such as the members of the Liverpool Biological Society. Our knowledge of fishery matters owes much to the investigations of such men in the past, and I hope will owe still more in the future. I do not doubt that any small expense the Committee may be put to in giving facilities to professional zoologists for pursuing their investigations at Piel will be well-spent money, and will bring in a good return in the form of increased

knowledge in regard to the conditions of marine life in our district.

"I should deprecate, however, the extension of any such facilities to students from our Colleges. There are plenty of *teaching* marine institutions already round our coasts to satisfy the demand, and at these institutions the students require and receive a great deal of attention, which we could not give them at Piel. Our Committee and our Institution have nothing to gain from such students, who would occupy work places much better reserved for professional or amateur zoologists conducting serious investigations.

"To sum up. For the reasons given above I should recommend:—

"1st—That Mr. Scott be instructed to devote all his attention to the hatching and rearing, and to allied practical investigations.

"2nd—That parties of fishermen be brought from time to time to have practical sea-fish hatching and rearing demonstrated to them.

"3rd—That any young men in training as fisheries experts be encouraged to come and study operations at Piel, after being through a zoological course at some University.

"4th—That no other teaching, either of fishermen or of ordinary science students, be attempted at Piel, but be left to other institutions, such as the College laboratories, which are fitted for that purpose, and where it can be done better, and without interfering with more important economic work.

"5th—That all possible encouragement be given to competent zoologists to come and pursue their investigations at Piel, free of charge.

"Further, as to the details of the economic work to be

undertaken at Piel, I feel that these must develop according to local circumstances and as opportunities arise, but I may put down as a general programme :—

"The hatching of ordinary food fish, such as Cod, Haddock, Whiting, Plaice and the allied flat fish.

"The development and after-rearing of such young fish as are hatched.

"The cultivation of the food of fish, especially of young fish.

"The hatching of Lobsters' eggs both in shallow tanks and in McDonald jars.

"The rearing of young Lobsters, and the stocking of of suitable spots on the scars.

"The investigation of the feeding and breeding and the life history in general of shell-fish, and especially of the Mussel and the Cockle.

"The laying down of Oysters, and various other experimental attempts to improve our local shell-fish cultivation, and re-stock the beds.

"There are various other more theoretical and general items of work, such as the codifying of the statistics obtained in the district, enquires into the distribution and migration of fishes throughout the year, and so on, which will probably be better done at the Liverpool Laboratory, where large libraries are at hand, and where other scientific opinion is available for consultation; but possibly Mr. Scott might be able to help in that work also at times of the year when he is not very fully engaged with his more special economic operations. Similarly the Assistant at the Liverpool Laboratory will be able to help Mr. Scott when there is a press of work at Piel.

"This programme of work for Mr. Scott ought to be regarded as rather elastic, and susceptible of modification or extension as needs may arise from time to time.

October, 1897. (*Signed*) "W. A. HERDMAN.'

Sea-Fisheries Exhibition.

As the Sea-Fisheries Committee desired that Lancashire should be represented in the Yachting and Fisheries Exhibition held at the Imperial Institute last summer, Mr. Dawson and I, with the assistance of Mr. Scott, arranged, during the spring, an exhibit which should illustrate both the administrative and the scientific sides of the Committee's work. As it was clearly important that the exhibit should be available for use locally in different parts of Lancashire, three light but substantial pitch pine museum cases, so constructed that they could readily be taken to pieces and packed up for transit by rail, were made for us by Mr. R. Garner, the Superintendent of the Wood-working Department of University College. These three cases (labelled A to C) showed, as arranged at the Imperial Institute, in April:—

A. Examples of the results obtained from the scientific work in the Fisheries Laboratory.

B. Samples of the scientific papers and reports and the statistics and other statements as to the fisheries published by the Committee, and of photographs, drawings, and lithographic plates illustrating the fishery work of this district.

C. Specimens of fish taken with various nets, samples of meshes, models of nets and various other fishery implements, gauges, and other illustrations of the work of the Administrative Department.

These three cases together cover all the varied activities of the Committee's work. In addition our exhibit included samples of nets and trawls, maps, charts, regulations and notices, models of boats, &c., &c.

The Lancashire exhibit was not at all well placed at the Imperial Institute. In place of being beside the

other scientific exhibits—such as that of the Marine Biological Association—in the large north gallery, it was in a small badly lighted annexe; but several scientific men and others (such as the editor of the "Fish Trades Gazette") remarked publicly upon the interesting and important nature of the Lancashire Exhibit.

At the close of the London Exhibition the cases and their contents were brought back to Liverpool, and, with the sanction of the Committee and the permission of the authorities of University College, Mr. Scott and I arranged, during the autumn, a small but representative Sea-Fisheries Exhibition, of which the London Exhibit formed the nucleus, in the College Museum of Zoology. This exhibition was formally opened by the Chairman of the Lancashire Sea-Fisheries Committee in the presence of a representative audience on October 29th. An address was delivered by Mr. Fell upon "Some Aspects of the Work of Sea-Fisheries Committees, and speeches were made by the Principal of University College, the Chairman of the Technical Instruction Committee of the Liverpool City Council, and others. The exhibit was then opened to the public during the next few weeks on certain hours and days. At the end of three weeks I was able to report to the November Meeting of the Committee that over 1000 persons had visited the exhibition, and when we finally closed it at the end of the year, the total number of visitors was 1,550. On several days set demonstrations or explanations of the collection were given to a party of Board School teachers, to a group of fishermen from Hoylake, and to a company of children.

The museum, the nature of its contents, and the speeches at the opening of the exhibition were very fully and favourably reported by the Liverpool Press, and there is reason to believe that not only was the exhibition of

interest to many people in Liverpool and the neighbourhood, but that it led to a more general diffusion of useful information as to the objects of our Sea-Fisheries Committee and as to its methods of work. It is only in this way, and by courses of public lectures, that we can hope to secure a wider knowledge and appreciation of fisheries work, of the object of regulations, and the value of scientific investigation. The Catalogue of the Sea-Fisheries Exhibition, as arranged in Liverpool, is appended to this report.

"Plankton" Investigation.

One of the most important determining factors in the distribution and movements of fish is clearly their food. In past reports we have given a considerable amount of information of the same kind as has been given elsewhere by other fishery investigators, as to the more or less fixed food derived from the sea bottom in the case of most of our common edible fishes. We are now making a more systematic study than has yet been done in this district of the floating and drifting fish food found in the surface and deeper layers of water throughout the sea, and which is coming to be called "plankton." Much of the plankton consists of microscopic plants and animals which are, throughout their life, in a free condition. But another important constituent is the enormous quantity of eggs, embryos, and larval stages of many animals which, in the adult condition, are to be found on the sea bottom. These young stages are most of them only to be found at certain times of the year, and consequently the plankton differs considerably, both in nature and amount, according to the season, and also, to some extent, according to the weather. As the plankton is liable to be moved about from place to place by tidal and other currents, by pre-

vailing winds and by exceptional gales, it is evident that its condition in our area of the Irish Sea must be affected somewhat, from time to time, by that of the west coast of Scotland, of the Irish coasts, and of the Atlantic. As the plankton is a very important element of the food of many of our fishes in their younger stages and of some even when full grown, it can scarcely be doubted that a detailed knowledge of the condition and movements of the plankton throughout the year will give us important information as to the distribution of fish.

For the last ten years the Liverpool Marine Biological Committee have been paying more or less attention to the plankton during their numerous dredging expeditions in the Irish Sea, and in the Eleventh Report of that Committee, just published, a summary is given of the chief observations which have been made up to the present.*

A year ago, with the help of Mr. Andrew Scott, I organised a scheme for the weekly collection of surface plankton throughout 1897 at six stations in our district. The localities were Port Erin (I. of Man), New Brighton (near Liverpool), Lytham and mouth of Ribble (coast of Lancashire), Piel (Barrow Channel), and from the Fisheries steamer, at sea, wherever she happened to be. The collections were taken, preserved, and sent to the Laboratory at Liverpool, where they were measured by Mr. Scott and then examined in detail. The scheme was started towards the end of January, and was kept up as regularly as possible—perfect regularity is not possible, first, on account of the weather, and secondly, because the bailiffs who take the gatherings are liable to

* Prof. M'Intosh had carried out similar investigations for the Scottish Fishery Board in 1888 (see Seventh Ann. Rep. Fish. Bd., Scot., p. 259, 1889). More recently Messrs. Bourne, Bles, Garstang, and others at Plymouth have recorded the variations in the plankton at different times of the year.

be called off occasionally to other duties. During the first fourteen weeks the number of gatherings received out of the possible six were—5, 6, 4, 3, 4, 2, 3, 4, 4, 3, 3, 5, 3, 4.

These gatherings, which have been worked up fully, bring the record up to the end of April. The rest of the collection, which is now in process of being examined, consists of some sixty tubes, giving an average of nearly two a week for the remainder of the year. Taking these statistics, along with the many previous less complete records that we have, extending back for ten or twelve years, there are some prominent features of the collections, looking at them week by week and month by month, that arrest attention—the abundance of *Sagitta* in January and February; the comparative scarcity of Copepoda early in the year; the abundance of diatoms, such as *Biddulphia*, *Coscinodiscus*, *Rhizosolenia*, and *Chætoceros*, in February and early spring; the appearance of Nauplei and then other larval forms in February and March; the comparative scarcity of plankton all round in February and March (except when gelatinous Algæ sometimes swarm in the latter month); its increase in April, and especially the increased abundance of pelagic Coelenterates and of Copepoda in early summer; the appearance of fish eggs and embryos and larval fish in abundance about Easter; the disappearance of Nauplei and other larvæ as summer goes on, and the great increase in Medusæ and Ctenophora; the quantities of *Oikopleura* which appear in the height of the summer; the abundance of Dinoflagellates in late summer and autumn; the great relative abundance of life in general during July, August, and September; and lastly, the rapid diminution in the amount and variety of plankton during the last few months of the year.

There are, on the other hand, some organisms, such as the Algæ *Halosphœra* and *Tetraspora*, the Infusorian *Noctiluca*, and the Copepod *Anomalocera*, which seem to vary greatly in their abundance from year to year; but probably when we have a more complete knowledge of the plankton of the North Atlantic, and of the relations existing between physical conditions and the distribution of organisms, we shall be able to assign rational causes for these curious irregularities in the floating population of our seas. To give an example of such irregular distribution, one of our very few records of *Noctiluca* during the year is "off the Morecambe Bay Light Vessel," on June 28th, when it is said there were "miles of this material." The gathering consists entirely of *Noctiluca*. It was taken during a heavy thunderstorm.

It is interesting, in this connection, to note that of all the tow-net gatherings which I took this summer in crossing the Atlantic twice, between Liverpool and Quebec, once at the beginning of August, and again at the end of September, those from the sea around the Isle of Man, between Liverpool bar and the north of Ireland, were the richest in species. The lists of organisms observed in the gatherings in question, are given in full in a paper which has been recently published by Mr. Thompson, Mr. Scott, and myself.*:—

We have arranged that during 1898 plankton gatherings will be taken weekly at the same six localities as in 1897, but a little further out to sea to avoid the disturbing influences of the shore.

Experimental Sea-Fish Hatching.

During the last spawning season we continued our experiments, commenced the previous year, on the hatch-

* Trans. L'pool. Biol. Soc., vol. XII., p. 33.

ing of edible sea-fish in our local waters. Mr. Scott carried on the work in the boat-house at Piel, in order to test the water of the Barrow Channel, while I repeated the experience of the previous Easter at Port Erin in the south-end of the Isle of Man.

About the middle of April the Sea-Fisheries steamer, "John Fell," came to Port Erin under the direction of Mr. R. A. Dawson, for the purpose of searching for spawning fish. On Saturday, April 17th, we trawled mature fish of various kinds both flat and round, but did not succeed in getting both males and females of the same species in the ripe condition, and consequently no eggs were fertilized. On Monday, April 19th, we were more fortunate, and obtained to the north-west of Port Erin Lemon Soles and "Witches" spawning, and were able to fertilize the eggs. We also found spawning Megrims *(Arnoglossus laterna)*, and, as an experiment, we fertilized the eggs with the milt of a ripe Cod. As a result large numbers of the following embryos were started on their development in the Aquarium on the afternoon of the 19th:—

In tank I.—Lemon Soles *(Pleuronectes microcephalus)*.
In tank II.—"Witches" *(Pleuronectes cynoglossus)*.
In tank III.—Ova of Megrim fertilized by milt of Cod.

The arrangement of the hatching tanks, and the apparatus for the circulation of the water was described and illustrated in last year's Report.* The water during the hatching kept at a specific gravity of from ·26 to ·27 and at a temperature of from 46° to 47° Fahr. The cross between the Megrim (a flat fish) and the Cod only developed for from three to four days, and then all the embryos became abnormal and distorted, and died.

* See also Trans. Biol. Soc., vol XI., p. 67 and Pls. I.—IV.

On April 26th the Witches began to move inside the egg covering, on the 27th the Lemon Soles were wriggling, and on the 28th both hatched out, eight and a half days after fertilization of the eggs.

Mr. Scott went to Piel at the beginning of March for a couple of months in order to test the water there by seeing how the keeping of various marine animals and the hatching of spawn compared with our experiences at Port Erin. I give further on (p. 29) Mr. Scott's report to me upon his work at Piel, from which it is obvious that, although some measure of success was obtained in temporary premises under "make-shift" arrangements, the work was greatly hampered by the large amount of sediment in the water. We hope that the storage tanks and filter, which have now been established at the Piel Hatchery, will remove this difficulty, and will render the water more like that at the south-end of the Isle of Man, where no filtering is necessary.

We hope, then, in the present season, with a continuous supply of water, the larger tanks, filter, and more efficient apparatus altogether, to conduct the hatching work more successfully, and to deal with much greater quantities of eggs. When, however, the little fish is hatched out, only half the work—and that probably by far the easier part—is done. I think it most important that we should make all possible attempts to rear the fry through their larval and post-larval stages, as far as possible, before setting them free in the sea. For this purpose other tanks, besides the hatching ones, will be necessary; and shallow ponds in the open air, or enclosed areas of the sea shore, would be a great advantage. The most suitable food, whether natural—such as diatoms, copepoda, and the like—or artificial, for each stage, will have to be ascer-

tained, and, if necessary, reared and kept in ponds for the purpose.

It is interesting to notice that Mr. Harald Dannevig has been experimenting with the fry of plaice in this manner at the Dunbar Hatchery of the Fishery Board for Scotland (see Fifteenth Report, p. 175, 1897), and has succeeded in rearing them through their post-larval stages until they had undergone their transformation into little plaice and settled on the bottom.

In the Eleventh Annual Report (for 1896) of the Sea-Fisheries Inspectors for England and Wales, Mr. C. E. Fryer makes some interesting observations upon the results obtained by the artificial hatching of sea fish, especially in the hatcheries of Newfoundland and the United States. Upon some of these reports, and Mr. Fryer's comments, I desire to make some further remarks. According to the Director of the Hatchery near Arendal, in Norway, about 300,000,000 Cod can be hatched for an expenditure of about £600, that is at the rate of a million for £2, or something over 2,000 young fish at the cost of one penny—a very moderate cost if even a few only of the fish grow to maturity, or if, by increasing the swarms of young fry, which must be eaten by their natural enemies, they so enable some of the (perhaps stronger) naturally hatched fish to escape destruction.

Mr. Fryer's comments upon the figures which he quotes in connection with the hatcheries of Newfoundland and the United States, rather give the impression that he is disappointed at the absence of more definite results, and that he feels that an absence of increase, or even a decrease in the fisheries, is not compatible with the claim that the addition of millions of artificially hatched fry to the sea must be a benefit to the local fisheries. But it is, perhaps, unreasonable to expect, as the Commissioner of

Fisheries in Newfoundland remarks in his Report for 1895, a great increase of fish after such a short trial of artificial hatching. A Cod fish requires four years to reach maturity. A vast number of the young Cod fish planted must perish from natural causes, and only a small percentage can be expected to grow up and form marketable fish.

The increase to a fishery can, therefore, only be gradual, and time is required to determine the value of this important experiment. I may add that it may well be that a fishery which is not increasing is still greatly benefited by the results of artificial hatching. On the other hand, I think it quite as unreasonable to attribute any marked increase of fish in a district entirely to the hatching operations, unless it can be definitely proved that the young fish caught are the produce of the hatchery. I agree with Mr. Fryer that, in the case of the reported increase of Cod in the neighbourhood of Dildo during 1895 (and again in 1896), it is at least as reasonable to attribute the early catch of the fish to natural conditions, such as the increased temperature of the water, as to claim it as a result of the artificial hatching of a few million of Cod eggs at that place in 1890 and 1891. The careful observations of the Fish Commission have established the fact that the Gulf Stream fluctuates considerably from time to time in its extension towards Newfoundland in the north, and we now know that the tile fish *(Lopholatilus chamæleonticeps)* is influenced in its distribution on the east coast of North America by the condition of the Gulf Stream. The Cod, and other fishes, are probably also affected in a somewhat similar manner. But all this is absolutely no argument against artificial hatching. Natural circumstances will be sometimes with us and sometimes against us, and when they are with us they

will probably be more powerful than anything that man can do; but whether under favourable or adverse circumstances man's little effort should also be made to restore the balance of nature by returning to the sea some proportion of what he takes from it.

This is likewise true of Lobster hatching, and it is important to note that the greater number of the eggs from which young Lobsters are hatched in American hatcheries are taken from parent Lobsters which are on their way to the tinning factories; and, therefore, it may fairly be claimed that millions of embryo Lobsters are saved from certain destruction, and given a chance at least of prolonged life and of reaching adult size.

There are a couple of Mr. Fryer's general observations in regard to which I would make a remark, because I believe he has pointed out difficulties in the artificial operations which it is important to guard against. He remarks that "the tendency under the artificial conditions of a hatchery is towards an increased temperature, which hastens development of both ova and embryo, and causes them to anticipate the natural period for hatching, regardless of the general climatic conditions of the season." Well, this must be prevented, and it is not difficult in early spring—the usual hatching season—to keep the water in the tanks as cool as that in the sea. In the height of summer it is different, but at that time the sea itself is probably sufficiently warm to prevent there being any ill results from a few days anticipation of the period at which the hatching would take place in nature.

Mr. Fryer says further:—"Then—as to the circumstance under which the young fry are 'planted'—while they would be hatched naturally in deep open water, of a high density and comparatively low temperature, they are almost of necessity liberated in shallow water, of

relatively low density and high temperature." I fail to see the necessity, and I feel it very important that fry should not be liberated in such unsuitable waters. We must endeavour to plant them in the localities where they are naturally found, and in the condition under which they are naturally deposited and developed, so that they may grow and be distributed in the pelagic waters in the ordinary course of nature, and find their way gradually into the shallow water nurseries. It will be easy, for example, in our own district to carry this out by running the boxes of fry on the steamer out into deep water over the natural spawning grounds before setting them free. I hope, however, that before long we shall have taken the further step and be attempting to rear some of the newly hatched fry to later stages within enclosed areas.

The Fishery Board for Scotland, in their "General Statement" (see Fourteenth Annual Report, 1896, p. 10) as to the utility of Sea-Fish Hatching, say:—"The artificial propagation of the food fishes on a large scale may now be regarded as having passed beyond the sphere of experiment, and taken its place as a department of practical pisciculture," &c. I do not go quite so far as that, but would regard the operations as being still in the experimental stage, although I consider the experiment as being of very great importance, and one it is the duty of fishery authorities to test thoroughly, and I agree rather with their further remark from the same page of the Report:—"It is, however, of importance that the economic results of marine pisciculture should be as speedily as possible ascertained. Its utility as a means of benefiting the sea fisheries depends upon the extent to which it is likely to increase the abundance of the fishes propagated."

Marine biologists and fisheries authorities everywhere

must be anxious to see some definite scientific experiment carried out which would gauge the extent of the results of artificial hatching in a given area, but such an experiment is, from the nature of things, most difficult to devise and to keep free from disturbing elements. It is not difficult, perhaps, to define the conditions of the experiment in words, but it is very difficult to carry them out satisfactorily in nature. What is wanted is a fjord or circumscribed sea area of which the fish population is approximately known, or in regard to which, at least, we have reliable statistics extending over a number of years, so that we know what an average catch, under given conditions, ought to consist of. To this area the hatched fry must be added, and the fishing must be regulated, and exact records of both processes kept. The experiment must run for at least five or six years—better ten—so as to allow time for the growth of the fish and to eliminate any possible climatic disturbances during a few of the years. It would be important, as a control experiment, to have a second similar area, close at hand, under similar physical conditions and in which the same amount of fishing is carried on, but to which no fry are added.

Dr. C. G. Joh. Petersen, of the Danish Biological Station, in his last Annual Report (VI., 1897) upon the conditions of plaice population in the Limfjord, expresses his conviction that there is an abundant supply, or in his own word, an "over-population," of young plaice produced naturally in the German sea, and that the difficulty to be met lies, not in a scarcity of fry, but in securing that the young fish, having passed through all the dangers of early life, shall be spared from capture until they have reached the age at which their marketable value is greatest. He recommends, therefore, a system of artificial transplantation to suitable grounds, such as some parts of the

Limfjord, of undersized plaice, and he considers that this might lead to a great increase in the value of the plaice fisheries.

This superabundance of young plaice may possibly be present in some special localities, but I doubt whether it is at all general, and I do not see how, in the face of natural enemies and of fishing operations, we can speak of an over-population anywhere until it has been proved that there are more young fish than the ground and the food will support. I do not think that there is any evidence that anywhere in our district have we any young fish to spare. But still Dr. Petersen's observations are full of interest, and I think we might benefit by his suggestion in one particular. In view of the destruction of young fish effected in some of our nurseries by the Shrimp trawlers, it might be well to carry out transplantation experiments, such as those he proposes for Denmark, and remove some millions of young plaice and other immature fish from grounds where a large proportion of them are doomed to destruction, to other localities of a suitable nature where they can feed and grow in peace. The institution of "sanctuaries" amongst our fish nurseries is eminently desirable.

Oyster Investigation.

The investigations on the bacteriology and various diseased conditions of Oysters and other shell-fish, and on their possible connection with public health questions, are still being carried on by Prof. Boyce, Dr. Kohn, and myself. In July we communicated a paper to the Royal Society, giving an account of the presence of relatively large quantities of copper in certain green leucocytes found in a diseased condition of the American Oyster as bedded on our coasts. The Oysters suffering from this

leucocytosis are always more or less green, but must not be confounded with ordinary green-gilled Oysters, where the colour is due to a totally distinct cause. Later in the summer, at the Toronto meeting of the British Association, we gave a further account of our investigations up to date, and from that report I quote the following account of the micro-chemical part of the work * :—

"The following are our details of the histo-chemical investigation of the pigment. The green pigment is insoluble in boiling alcohol, ether, chloroform, xylol, and other fat solvents; it is soluble in dilute acids and alkalies. The addition of potassic ferrocyanide to sections containing the green colouring matter, or to the leucocytes themselves, gives a red reaction, indicating the presence of copper; but the reaction can be most readily obtained by the addition of a small quantity of ·5 per cent. hydrochloric acid to the potassic ferrocyanide. Ammonium-hydrogen sulphide gives also an immediate reaction with the green pigment. Ammonia strikes a beautiful blue wherever there is a green. It was then found that pure hæmatoxylin is an extremely delicate test, giving an immediate blue reaction in exceedingly dilute solution. Previous treatment of the green colouring matter by 3 per cent. nitric acid in alcohol prevented these reactions, and subsequent treatment with acidulated potassic ferrocyanide resulted in a very faint general prussian blue colouration of the tissue generally. We concluded that there was *no inorganic iron* present in the leucocytes, that the leucocytes which form the green patches contain a considerable quantity of copper, and that, just as in the case of iron, as shown by Professor Macallum, pure hæmatoxylin is a most delicate test, but that great care must be taken to

* For further details on some points see Proceedings of Royal Society, vol. LXII., p. 30, 1897.

ascertain by other reagents which of the metals is present. Very numerous tests were made with the blood obtained from white Oysters, and micro-chemical reactions revealed in some instances faint traces of copper. Hæmocyanin has been described in the blood of Molluscs and apparently in the blood of the Oyster. We have examined numerous samples of blood taken from the white Oyster, but have failed to get any blue colouration on exposure to air. In the green Oysters a very faint blue colour has been noticed in some cases on exposing the blood to air."

I quote the following conclusion from the Royal Society paper:—

"Our results demonstrated the presence of copper in comparatively large quantity in the green leucocytes, chiefly in the American Oyster, but also in the "natives" from Falmouth and other localities. We have shown that the colour was in proportion to the amount of copper present, and that the colourless leucocytes contained only traces of that metal. The deposition of the copper in this large quantity appears to us to represent a degenerative condition. It was accompanied by a most striking increase of leucocytes, which tended to distend the vessels and to collect in clumps, phenomena which are abnormal in our experience in the Oyster. The presence of the copper in the leucocytes in these cases might be compared to that of the iron which is met with, in man, in some of the leucocytes in cases of old hæmorrhages, pernicious anæmia, or in other cases where iron is set free. We are not prepared to state whether copper in the food can bring about this condition, but certainly we have abundant evidence to show that it can occur where no copper mines or other evident sources of copper are present.

"We are inclined to suggest that the increase in copper may be due to a disturbed metabolism, whereby the

normal copper of the hæmocyanin, which is probably passing through the body in minute amounts, ceases to be removed, and so becomes stored up in certain cells."

PRELIMINARY EXPERIMENTS AT PIEL.

Mr. Scott gives me the following report upon his work, at the Piel Hatchery, during March and April, 1897 :—

"In accordance with instructions received from the Scientific Sub-Committee, through Prof. Herdman, I went to Piel on March 2nd, for the purpose of carrying out the various experiments suggested in order to test the suitability of the water there for fish hatching, and for the study of the development and life histories of economic marine animals in general. I remained there, with the exception of a fortnight when I was recalled to Liverpool to assist in the preparations for the Fisheries Exhibition, for practically two months.

"The experiments were carried out in the old Life-Boat house, which had been fitted up as a temporary laboratory and tank house, and the apparatus used was a set of three tanks, exactly similar to the ones used in the experiments at Port Erin last year (see Report for 1896, p. 12) ; a few smaller tanks and glass aquaria were also employed from time to time. Owing to the structure of the place, the lifting apparatus, described in our last Report, could not be used for circulating the water, so we had to put up a store tank capable of holding about 200 gallons, which the bailiffs filled up as required; from this tank the water was siphoned off into the uppermost of the three tanks and allowed to circulate by gravitation throughout the system. The apparatus was put into working order with the least possible delay, and everything made ready for the reception of the fertilized eggs.

"An accident to the steamer, rendering it unfit for sea,

prevented it from being placed at our disposal to obtain the required fertilized eggs, but through arrangements made with Mr. Leadbetter, of Fleetwood, a member of the Committee, I was permitted to visit the fishing grounds in the sailing trawler 'Harriet.' Accompanied by one of the bailiffs from Piel, we left that place early on the morning of the 10th March, having previously arranged to meet the 'Harriet' outside the harbour not later than 6 a.m. A heavy sea was running outside, and no sign of the vessel could be seen, so it was decided to run to Fleetwood, and on arrival there we found that she had not gone out owing to the storm. By this time, however, the weather showed signs of improvement, and the captain arranged to sail that same afternoon. During the time we were waiting at Fleetwood we visited the fish market, and had a look at the condition of the fish landed from the trawlers that morning, and found that the majority of them had been nearly mature when captured.

"On putting out to sea the captain of the 'Harriet' decided to try the off-shore fishing grounds lying in line with St. Bees Head and the north end of the Isle of Man, whence most of the fish were being taken. The first hauls were unproductive of spawning fish, and it was not till midnight of the 11th March that we were successful in our search. In this haul spawning Cod and Haddock were found, the eggs were quite mature, and no difficulty was found in 'stripping' the fish and afterwards fertilizing them. After fertilization, the embryos were placed in clean buckets filled with fresh sea-water, and everything made ready for running into Piel Harbour at daylight. Unfortunately, however, during the night a heavy sea broke on board, carrying away the buckets from their fastenings, and sweeping the contents overboard. In the next haul mature Haddock were again found, the eggs of

which were again successfully fertilized, and this partially replaced the lost lot, but it was noticed that this second set were not quite so mature as the previous ones, and the eggs did not run so freely from the parent fish. During the succeeding haul the entire net was carried away, and there being no spare one on board, we had, therefore, to return to Piel with only a small quantity of fertilized eggs as the result of two days' fishing.

"The police boat was awaiting our arrival outside the harbour, but the sea was too rough to board, so the 'Harriet' had to bring us inside. Once inside the harbour, the embryos were conveyed ashore and transferred to the tanks without further loss of time, the dead ones being first carefully removed. The embryos floated quite freely upon the surface of the water, and development followed its natural course, as could be seen by frequently examining the embryos under the microscope.

"Probably owing to the eggs not being quite mature when obtained, and to injuries received subsequent to fertilization, a considerable daily mortality took place amongst the embryos, and at the end of nearly 200 hours after fertilization, all had died and sunk to the bottom of the tanks.

"During the whole time that the embryos were under observation, the temperature and specific gravity of the water was taken daily. The temperature varied from 5·8° C. to 6° C., and the specific gravity from ·23 to ·24. Although we were not fortunate in having the embryos hatch out at this stage of the experiment, it was clearly demonstrated that the specific gravity of the Piel water was sufficiently high to keep the eggs afloat.

"At this point I had to return to Liverpool, but Mr. Wright, chief bailiff, was left in charge of the place with instructions to endeavour to obtain more fertilized eggs at

the first opportunity. In this he was successful, for on boarding a trawler fishing on the off-shore grounds on April 1st, mature Cod and Haddock were found, and the eggs fertilized ; these were conveyed to the tanks in the manner already described, so that when I returned on April 9th, the embryos had been in the tanks for eight days, and development had proceeded so far that the larval fishes were clearly visible through the egg membranes. Considerable mortality had taken place amongst the embryos, and that continued to the end.

"The embryos began to hatch out on the eleventh day after fertilization, and the last of them hatched out the following day. The larvæ gradually dwindled in number from day to day till at the end of seven days only one remained alive; the survivor was lost next day through being carried away by the vessel accidentally overflowing. Before my arrival the tanks had overflowed, the one into the other, thus mixing the embryos so that it is difficult to say now whether the larvæ of both Cod and Haddock were hatched.

"This second experiment shows that it is possible to hatch out the embryos in the tanks supplied with sea water from the channel, and to keep the larvæ alive for several days after hatching. Further experiments are necessary in order to ascertain for how long a period the larvæ can be kept alive by feeding them with 'plankton' collected in our tow-nets.

"For the greater part of the time that the hatching experiment was in operation, the water was used just as it was taken from the channel, and during all that period the weather was very unsettled, the sea washing up the mud and making the water, on some days, quite turbid; the fine mud consequently got in amongst the embryos, and, no doubt, had a bad effect upon them by adhering to

the outside of the egg membranes, and thus increasing their specific gravity beyond the point capable of floating in the water. On several occasions when the supposed dead embryos were examined, it was found that they were alive, and, on the removal of the coating of fine mud, the embryos again floated freely on the surface of the water.

"Towards the close of the hatching experiment, the water was passed through an ordinary flannel jelly bag before being allowed to enter the tanks, and by this means it was found possible to entirely remove the suspended matter, the water passing into the various vessels in a perfectly transparent condition; but, owing to the lateness of the season, and the arrival of workmen to make the necessary alterations for converting the premises into our present hatchery and laboratory, no further hatching could be tried with the filtered water.

"Besides the fish hatching experiments now described, other investigations were carried on as well, and these included visits made from time to time to the various shell-fish beds in the neighbourhood, for the purpose of examining their condition and collecting samples for working at in the laboratory and for testing the water in the tanks. We had, therefore, many economic marine animals living satisfactorily in the tanks during the two months; these consisted of various kinds of fishes, including small Soles, Plaice, and Dabs; shell-fish, including Mussels and Cockles, and also a couple of Oysters found living in the vicinity; Crustacea, including Shrimps, Lobsters, and Crabs, and other invertebrates which, although not directly valuable, are yet indirectly so, from the part they play as the food of other marine animals. Many of the Shrimps were egg-bearing females, and the more mature ones were taken from amongst the others and kept in separate vessels; so on several occasions we

had batches of newly hatched Shrimps in our glass jars, which were kept alive until the temporary laboratory had to be dismantled. One of the Shrimps on completion of the hatching out of the larvæ, cast its shell; both the shell and the animal were preserved, and are now in the Fisheries Collection at Liverpool.

"Early in February the bailiffs noticed that the rough ground between tide marks eastwards from Foulney was covered with young Mussels, and after my arrival I visited the various places pointed out, and found that everything was covered with the young shell-fish, the sizes of which varied from one-sixteenth of an inch to one-quarter of an inch. Whether these young Mussels are the result of the previous summer's spawning or not is at present difficult to say, as the rate of growth of this shell-fish depends a great deal upon its surroundings, food supply, &c., matters which can only be found out after lengthened investigation of any particular bed. Although numerous samples collected from the different Mussel beds in the neighbourhood were examined, on spawning shell-fish were found. The Cockle beds were also examined for spawning Cockles, but none could be discovered.

"Now that the Piel Marine Laboratory is completed and in working order, a close examination of the various shell-fish beds in the neighbourhood will be kept up throughout the year: (1) by weekly examinations of the shell-fish themselves for approaching maturity and time of spawning, and (2) by frequent tow-nettings in the vicinity of the beds for the free swimming larvæ.

"During the spring tides of March Mr. Richardson, one of the bailiffs, secured a 'berried' Lobster, which had been taken on the scar referred to in last year's Report, and brought it to the laboratory, where it was

placed in a tank and remained alive till after the place was dismantled. When the workmen arrived the tank containing the Lobster was transferred to the boat-house, formerly used by the Customs officials and now by the bailiffs as a storeroom and workshop. Later on in the spring another 'berried' Lobster was found by Mr. Wright, and placed in a second tank alongside the other. The Lobsters remained alive till well on in the summer, when one accidentally died, and the other was then placed in our wooden 'Lobster tank' on the shore. On being examined there from time to time, it was found that the 'berries' were gradually disappearing from the swimmerets, and eventually they had all gone. Probably the embryos hatched out and passed away into the open channel. With the better accommodation we now have, and the more suitable appliances in our new tank-room, it is expected that successful hatching of Lobsters will fall to be recorded in due course. It is so far satisfactory to find berried Lobsters in our own immediate neighbourhood, and the frequent occurrence of young ones, ranging from four inches upwards, points out the probable close proximity of a small Lobster rearing ground somewhere in the channel, which future investigations may yet bring to light. The Lobster tank on the shore still continues to prove satisfactory, notwithstanding frequent silting up, and several of the Lobsters have cast their shells during the past year.

"The Mussel Bouchot so far has not fulfilled our expectations, and this is probably due in large measure to the strong tides which sweep over the ground in its neighbourhood, so that very few of the original Mussels now remain upon it. In the spring of the past year a considerable number of young Mussels were observed amongst the material composing the Bouchot, and on several occasions

pieces of old stakes thickly covered with Mussels, of all sizes, were removed from the scars and fixed in the structure, but in a very short time all had disappeared. A further trial will, however, be given it during the present year, and, as soon as possible, it is intended to re-stock it."

Notes on the Shad.

(By Mr. R. L. Ascroft.)

This fish, whose scientific name is "*Clupea alosa*," belongs (as that appelation imports) to the Herring tribe. It is found in the Mediterranean and along the Atlantic and North Sea coasts of Europe, as far as Jutland. In this country it is plentiful in the Severn, and I have taken several on the Lancashire coast in a mackerel baulk at Formby. The Shad must have been numerous on the Lancashire coast, for in a lease of lands lying between the Ribble and the Mersey, one of the conditions of the lease was that one thousand Shad be delivered to the lessor by the lessee during the Shad season (Sceadda dagen), and, at the present time, all bright, silvery small fish caught in the Shrimp nets in the Lancashire district are called Shad by the fishermen.

Like the Herring, it is a migratory fish, but it continues its migration up the rivers for a short distance above the tidal waters to spawn. It enters the rivers in Holland from the middle of March to the middle of June, and proceeds up the rivers. In the Severn it is rarely seen above Worcester. The eggs, which are heavier than water, are laid by the female when in company of a male. The pair swim at night at or near the surface of the

water, and make a great noise (termed by the fishermen in the Potomac "washing"). The eggs sink to the bottom and are not adherent. The average number of eggs in an ovary is about 25,000, in some instances reaching 60,000. The diameter of the egg when laid is 1·5 mm., and it has the peculiarity that it rapidly absorbs water, reaching a diameter of 4·25 to 4·60 mm. In three to six days the young larvæ appear, having a length of 4·25 mm. They are provided with a yolksac of a diameter of 1·6 mm. Unlike the young salmon, although carrying as large a burden, they are, as soon as hatched, quick, active little fish.

The larvæ, after leaving the egg, grow very rapidly, arriving in September at a length of 100 mm., or four inches. They then proceed to the sea, and nothing is known of them after that until their return to spawn. When entering the rivers from March to June inclusive, they have arrived at lengths of from 57 cm. to 62·5 cm., average 60 cm., and weigh from 2·3 to 3·0 kilos.

In Germany and Holland a belief exists among the fishermen that the Shad are attracted by musical sounds, and they attach to their nets a number of small bells (klokijes) to attract the fish. [The above account is taken principally from the "Mededeelingen over Visscherij," for the months of April, May, and June, in which is an article by Dr. P. P. C. Hoek, Scientific Adviser in Fisheries to the Dutch government, entitled "De elft op onze rivieren," "The Shad up our rivers."]

It is most desirable to increase the Shad in our waters. There are ways in which it can be done. We might get live fish from the Severn, keep them until ripe, then strip them and hatch the eggs. I do not doubt but that ripe fish might be stripped at Cologne (Koln) on the Rhine,

and the eggs be sent over. Or the attempt might be made to obtain eggs or fry from Washington, D.C., of the American Shad *(Clupea sapidissima)*. There have been very successful plantings of the fry of this Shad in the Pacific, and they are now spread over a line of coast 3,000 miles long.—Robert Lamb Ascroft.

NOTE.—The Appendix which follows was printed in October, 1897, as a Guide to our Fisheries Exhibition. The Catalogue of the permanent Fisheries Collection in University College, Liverpool, was printed as an Appendix to the last of these Annual Reports.

APPENDIX.

GUIDE TO THE FISHERIES EXHIBITION,

Open during November and December, in the

ZOOLOGICAL MUSEUM

AT

UNIVERSITY COLLEGE, LIVERPOOL,

Arranged to illustrate the

FISHING INDUSTRIES AND THE APPLICATION OF SCIENCE TO AQUICULTURE.

THE Exhibition is in three Rooms—the MAIN HALL of the Museum, the FISHERIES ROOM, and the GALLERY.

The MAIN HALL contains, in the centre of the floor, the three cases which were prepared for the London Jubilee Exhibition, and which are described fully below; while round the walls are those parts of the College Zoological Collection which have a bearing on fisheries.

In some of the wall cases and on tables are samples of nets and models of fishing implements.

The GALLERY round the Main Hall contains the collections of Marine Lower Animals from Liverpool Bay and the neighbouring parts of the Irish Sea. These form, directly or indirectly, the food supply of our fishes.

The FISHERIES ROOM (Ground Floor) contains the permanent collection illustrating various branches of Aquiculture, and the Scientific Investigation of the Fisheries. A detailed catalogue of this Collection is printed separately.

MAIN HALL.

The Cases round the wall contain Back-boned Animals, arranged in Zoological order, commencing with FISHES to the left of the door and passing on to Amphibia, Reptiles, Birds and Mammals. Some of the land animals have been removed to give greater prominence to the marine forms. A group of the skeletons of Marine Animals (Whales and Seals) will be found on one of the tables, to the left of the door.

In the centre of the floor are three museum cases arranged to illustrate the varied work undertaken by the Lancashire Sea-Fisheries Committee. This Committee consists of 64 members, 36 elected by the constituencies and 28 appointed by the Board of Trade. The Chairman is Mr. John Fell, J.P., Ulverston, the Deputy Chairman Alderman E. Grindley, Liverpool, the Clerk Mr. H. C. Hulton, J.P., and the Deputy Clerk Mr. J. P. Muspratt. The Superintendent, Mr. R. A. Dawson, has under him the captain and crew of the Fisheries steamer "John Fell," and others, forming a staff of 13 bailiffs. The Honorary Director of the Scientific work, Professor Herdman, has under him as Fisheries Assistant Mr. Andrew Scott and as laboratory attendant Thomas Mercer. The Fisheries Laboratory is in the Zoological Department of University College, Liverpool, and the Marine Station and Hatchery (not yet completed) is at Piel, the most favourable position on the Lancashire coast for the purpose.

CASE A contains specimens of fish, shell-fish, fish-food, fish-spawn, etc., in illustration of some of the scientific investigations made in the fisheries laboratory. The exhibits in the case are :—

1. A series of the food fishes of our district, with the more important food matters of each, according to the observations in our laboratory. The fishes are arranged on the lowest shelf, on one side of the case, and their foods on the shelf above. The series is as follows :—

Fish.		Food.
Gurnard ...	...	Crustacea.
Cod ...	...	Crustacea.
Haddock ...	...	Mollusca and Echinoderms.
Whiting ...	...	Fishes.
Plaice ...	...	Mollusca and Annelids.
Lemon Sole	...	Annelids.
Dab ...	...	Annelids, Mollusca, etc.
Flounder ...	...	Annelids, Mollusca, etc.
Sole ...	...	Annelids.
Skate ...	...	Crustacea, etc.

2. A series of useful and useless fishes which compete with one another by eating the same food. Three pairs of such fish have been chosen for exhibition, and in each case the food has been placed between the useful and useless (or rather, unmarketable) fishes that eat it. The pairs are the Whiting and the Angler fish, which both feed on smaller fishes; the Cod and the Pogge, which both feed on Crustacea; and the Sole and the Solenette, which both feed on Annelids.

3. A series of fish parasites, both external, such as Caligus, Lernea, Chondracanthus, Anchorella, Pontobdella, and Saprolegnia (the Salmon disease fungus); and internal parasites, such as Cestode and Nematode worms.

4. A series of the ripe eggs of our chief food fishes. The fishes chosen are as follows:—Sole, Plaice, Witch, Scald fish, Lemon Sole, Dab, Haddock, Gurnard, Cod, Anchovy, and Lumpsucker. With the exception of the Lumpsucker, whose eggs sink in the water, and are, consequently found on the bottom or attached to sea-weeds, all these fishes' eggs are pelagic, or float at or near the surface of the sea. The small size and transparent appearance of most of them will be noticed.

5. Specimens of the Sole *(Solea vulgaris)* and the Solenette *(S. lutea)* at various stages of growth to show the similarity and the distinction between these two fishes. The only possibility of confusion is between the adult Solenette, which never grows larger than four or five inches in length, and the young Sole of about that size (see the specimens in the jars). Besides the occasional black stripes which the Solenette has in its dorsal and ventral fins (each sixth or seventh ray being coloured a deep black), the more sandy colour, the rougher appearance, and a difference in the arrangement of the tags around the mouth, there is also a considerable difference in the scales, as is shown in the figures and description appended to the exhibit.

6. Three food fishes of our district, the eggs of which were hatched out in the tanks of the Marine Biological Station at Port Erin in April, 1896, with specimens of their eggs and embryos preserved at various ages—24 hours, 66 hours, 114 hours, and 168 hours. The three fishes are the Grey Gurnard, the Lemon Sole, and the "Witch."

7. A series of the shell-fish of our district, showing stages in life-history and growth, legal and illegal sizes, injuries and repairs, pearl formation, and pearls.

8. Jars showing the Shrimp and its food. For the other economic crustacea see the window case in the Fisheries room.

9. Jars showing the Sole, "Flustra" ground, and the food of the Sole.

10. Piece of wooden stake covered with young mussels illustrating their mode of attachment on a Bouchot.

11. Series of Food Matters from the Sea; leading from Mud through Diatoms to Copepods, then through other animals to Pagurus, which is the food of the Cod.

Other scientific exhibits of a similar nature to those in Case A will be found in the cases round the Fisheries Room.

CASE B contains printed matter, plates, photographs, and drawings illustrating the publications, both administrative and scientific, of the Lancashire Sea-Fisheries Committee, and other work bearing upon the fisheries of the district.

One end of the case is occupied by the series of photographs taken recently by Mr. Andrew Scott to illustrate Mr. Dawson's lecture on the methods of fishing in Lancashire. These show the appearance of the fleets and the fishing boats, of different kinds, in different positions, and also such peculiar methods of fishing as the cart shrimp net, the power net, using the "jumbo" and the "craam," and "treading for cockles."

The opposite end of the case contains a set of drawings and water-colour sketches, made by Professor Herdman, in illustration of his joint investigation with Professor Boyce, on "oysters and disease." These show the external appearance and the internal structure of various kinds of oysters—natives, French, Dutch, and American, in both healthy and unhealthy conditions. Some of the drawings represent the minute structure as seen under the microscope.

A further series of drawings, and a large number of specimens, microscopic and otherwise, in illustration of the oyster investigation, will be found in another case.

At this same end of Case B, below the drawings, are exhibited some series of the microscopic slides which are prepared in the laboratory in the course of the scientific investigations. Some of them are thin sections of fishes and other marine animals, others are scales, eggs, embryos and various pieces of internal organs, prepared, stained, and mounted for microscopic examination.

Of the two sides of this case, the one is occupied by samples of the administrative literature, the other by the scientific. The administrative includes the superintendent's quarterly reports, the statistics, the various printed forms in use by the fishery officers, copies of the bye-laws, etc.

The scientific papers include the annual reports from the laboratory, syllabuses of courses of fishery lectures, catalogue of the sea-fisheries collection, papers on the marine fauna and flora of the district, report on shell-fish culture in France, and other papers; photographs and plates illustrating investigations by Professor Herdman, Mr. Scott, and others.

The upper part of this case is occupied, on both sides, by selected samples of the different kinds of lantern slides, photographs and diagrams, used at University College, Liverpool, in illustration of fishery lectures.

CASE C illustrates the Administrative work of the Committee, carried out by the Superintendent (Mr. R. A. Dawson) and his Assistants.

The principal exhibits are:—

1. The BYE-LAWS of the Committee for the purpose of regulating the fishing industries of the district.
2. Models of trawling nets of different kinds as used in our district.
3. Models of shrimp trawls.
4. Model of Fleetwood prawn ("red shrimp") trawl.
5. Model of improved form of shrimp net, designed by Mr. R. A. Dawson, to minimise the destruction of young food fish (see also description on card).

6. Patterns of the different sizes of mesh used in fish trawl and shrimp nets. The meshes are measured around the four sides. A "seven-inch-mesh" therefore is one having each side of the square $1\frac{3}{4}$ in. from knot to knot. The size of fish-trawl mesh ($4\frac{1}{2}$ inch) in use in this district before the institution of the Committee, and the size (7 inch) now enforced by the Committee's bye-laws are shown, as well as the smaller sizes (both old and new) used in shrimping and prawning, and the 5 in. and 6 in. mesh used specially for a fixed period in each year for the capture of soles (by deep sea trawlers on the off-shore grounds).

7. Two large glass vessels containing common food-fishes of various sizes, illustrating the average style of catch obtained by the nets in use before and since the introduction of the Committee's bye-laws. Reprints on cards of statistics from the Superintendent's reports are placed alongside and show the results of experimental hauls made with the two sizes of mesh ($4\frac{1}{2}$ inch and 7 inch). The four jars on the shelf above show the actual kinds and sizes of the fish caught by the 7 in. mesh, as mentioned in these statistics. The three jars below show those caught by the $4\frac{1}{2}$ in. mesh. The very large number of small sized fish destroyed by the smaller mesh will be noticed in these last jars.

8. Glass vessel showing an average sample of the fish caught in a shrimp net in some parts of our district. This illustrates the destruction to young food-fish caused by the indiscriminate use of shrimp nets in localities which serve as fish

nurseries. Statistics of actual hauls are given on the card alongside.

9. Model of improved Otter trawl net boards, lately invented and patented by Messrs. Richard Cowell and R. W. Mason of Fleetwood.

10. Model of shrimp hose-net, as used at Ince in Lancashire.

11. Model of shrimp push-net used in this district.

12. Models of craams, jumbos, rakes, and other instruments used for taking shell-fish (cockles and mussels) in our district.

13. Riddle (on one of the tables) to regulate the size of cockles collected.

14. Complete set of the testing gauges for sizes of meshes and of shell-fish, used by the fishery officers in enforcing the bye-laws of the Committee.

15. Facsimiles of the complete set of standard gauges as used in court in cases of prosecution.

16. Instruments used on board the fishery steamer "John Fell" for obtaining samples of water and for ascertaining the temperature at any required depth below the surface.

17. Set of Kiel hydrometers and thermometer used in taking the physical observations at the time of each experimental haul (in side case).

18. Badges, compass, and telescope as used by fishery officers in execution of their duties.

On the tables and in the cases round the walls of this room, and hanging from the roof, will be found the remaining models and samples illustrating the Lancashire fishing industries and the administration of the Committee's bye-laws. They are as follows:—

19. Model of the s.s. "John Fell," the Lancashire Sea-Fisheries Committee's steamer.

20. Model of the police sailing cutter.

21. Model of Fleetwood steam trawler "Bassein."

22. Model of Liverpool steam trawler, exhibited by R. Harley, Esq.

23. Model of full-rigged second class fishing boat "Arrow," of Fleetwood, with fish trawl.

24. Models of other fishing boats, etc., exhibited by Messrs. John Gibson and Sons, Fleetwood.

25. Model of a fish trawl net, arranged to show the different sizes and quantities of fish captured with large and small meshes respectively, as used in the investigations made by the Lancashire Sea-Fisheries Committee.

26. Model of sand baulk-stake net for taking flat fish.

27. Models of two fish trawls.

28. Mussel rake, as used in this district.

27. Full-sized river boat's fish trawl net (on roof).

28. Lines and tees for taking sea-fish (in side case).

29. Samples of illegal nets (in side case).

30. Tow-net for catching surface life.

31. Reversing deep-sea thermometer.

32. Naturalists' dredges, trawls and other nets.

33. Exhibited by the Anglo-American Rope and Oakum Co.:—

(1) Model of trammel net.

(2) Pollock, cod, mackerel and whiting lines.

(3) Sinkers for drift and seine nets.

(4) Specimens of twines used in manufacture of different nets.

(5) Samples of various hooks used for capturing sea-fish; flies used in trawling for mackerel; tripod hooks for trawling; swivels used in long lines.

(6) Samples of fishing lines used in district.

(7) Bow net for taking shrimps.

(8) Cast net used for scientific purposes.

(9) Prawn trap.

(10) Ground part of shrimp trawl neck and back of same.

34. Shrimp push net used in the district.

Also, round the walls and on tables will be seen:—

Maps of the district.

Tabular forms for use in the scientific work and by the bailiffs.

Photographs of biological stations and fish hatcheries (Tarbert, Dunbar, and Port Erin).

Photograph of improved trawling apparatus invented and patented by Mr. J. H. Maclure, of Hull.

Model of Dutch oyster farm, on the Schelde (see specimens illustrating Dutch oyster culture in Fisheries Room—H).

Model showing French Bouchot system of mussel culture, in the Bay of Aiguillon.

Model of the floor of the Irish Sea.

Samples of fishery reports, monographs, and plates from other countries (in side case).

Plan of the courses taken by drift bottles set free to determine the currents, specimen of drift bottle, and samples of the records returned.

On one of the tables will be found a series of microscopes showing fish eggs, and embryos, young stages of shrimps, crabs, etc., the minute structure of parts of fishes, and the microscopic food of fish and shell-fish.

Tow-nets, travelling microscope, and other appliances for collecting surface life of the ocean from vessels steaming at full speed, are laid out on a table in the Fisheries Room.

Alongside is Prof. Herdman's folding Deck-table fitted up with microscope, dissecting dishes, note-books, &c., for biological work at sea.

FISHERIES ROOM.

(On Ground Floor, to South of Main Hall.)

The specimens in this room exhibit :—

A. The Series of Fishes of the district—whether edible or not.

B. Series showing the Reproductive Organs, the Spawn, and the young stages in the development and life-history of Fishes from the Egg onwards.

C. Series of Foods of various Fishes, both young and old.

D. Series of Fish Parasites—internal and external.

E. Other Enemies of Fishes.

F. Collection showing Diseases or abnormal conditions of Fishes.

G. Collection of Edible Shell-fish of our district.

H. Collection illustrating Oyster culture in France, Holland, and other countries.

I. Collection of Edible Crustacea.

K. Collection of the Sea-bottoms and other submarine deposits.

L. Collection of Natural Baits used in the Fisheries.

M. Collection of Models of fishing implements, of apparatus for fish culture and hatching, and of shell-fish cultivation.

N. Series of Photographs and Lantern Slides illustrating the Lancashire Sea-Fisheries District.

O. Collection illustrating the Regulations of Sea-Fisheries Committees and other Authorities.

[For further details see the separate Catalogue of the permanent Fishery Collection.]

GALLERY.

(Stair from Vestibule.)

The collection of Local Marine Invertebrates, which occupies the greater part of the wall cases round the gallery, is largely the result of the work of the Liverpool Marine Biology Committee. The series commences to the left of the door with the Sponges, and continues round the cases labelled Cœlenterata, Echinodermata, Polyzoa, Vermes, Crustacea, Mollusca, and Tunicata.

In the windows of the gallery are arranged a series of lantern slides, prepared by the Rev. T. S. Lea, from his photographs of the sea-weeds and animals on the shore round the south coast of the Isle of Man.

In some of the desk cases round the rail of the gallery will be found a collection of Sea-bottoms, ancient and modern, both from shallow and deep water. These include a series of the gravels, sands, muds, and organic deposits found in the various parts of our own district.

Two of the desk cases, on the north side, show an interesting series of the Microscopic Copepoda, and enlarged representations of their structure, prepared by I. C. Thompson, Esq.

REFLECTIONS on the CRANIAL NERVES and SENSE ORGANS of FISHES.

By F. J. Cole,

Demonstrator and Assistant Lecturer in Zoology in University College, Liverpool.

[Read Feb. 11th, 1898.]

A few years ago, on being asked by Prof. W. E. Ritter, of California, what I was working at, and replying that it was the nerves and sense organs of fishes, he remarked that I was "in good company and plenty of it." Those who have started with Thomas Willis's "Cerebri Anatome," published in 1664, and worked onwards, will have realised that this observation is sufficiently well founded to entail in any work on the subject a somewhat considerable amount of bibliographical research. He will have realised, first, that Willis himself, if we consider his time, knew a very great deal, and second, that even his knowledge is but as the proverbial drop in the ocean compared with what his numerous successors accomplished. It will also have been patent that work which started with nerves often ended in something of a widely different character. The study of cranial nerves and sense organs, ndeed, involves problems of considerably wider import than those with which they are directly concerned, and, in fact, will always be an important factor in determining many problems of vertebrate phylogeny. In a forthcoming work, I have endeavoured, as far as opportunities permitted, to deal somewhat exhaustively with a portion of this extensive subject. I fully realise that this attempt is imperfect, but it is perhaps sufficient to form the basis of the following sketch, in which an attempt has been made to summarise a few of the more important results which have hitherto been established.

The older anatomists arbitrarily divided the cranial

nerves of vertebrates into a number of pairs,* of which ten could be distinguished in the lower vertebrates and twelve in the higher. That this arrangement is partly arbitrary and partly scientific is obvious enough. Arbitrary, since these nerves do not arise serially as ten or twelve definite pairs, but, to a considerable extent, overlap and intermix, so that in many forms it is still impossible to homologise several of the roots; scientific, since, for example, the nerve supplying the spiracular cleft in any one form must be held to be homologous with the nerve supplying the same cleft or its homologue in any other form. Recently a severe and perhaps fatal blow has been struck at the serial arrangement of the cranial nerves by the results obtained from an investigation of the central origins of the nerve fibres in many of the lower vertebrata. These researches have shown conclusively that the cranial nerves are not so many independent units, but are themselves complexes of fibres derived from various parts of the brain. For example, to adhere to our former illustration, the so-called "seventh" nerve has, in many of the lower vertebrates, not only three centres in the brain, but these three centres also do duty for the "ninth" and "tenth" nerves. The precise way in which the nerve fibres leave the periphery of the brain is therefore a secondary question, and, as far as central origin is concerned, it would be more philosophical to denominate as the seventh, ninth, and tenth nerves, *not* the "roots" of the nerves, but respectively the three nuclei from which those roots are compiled. And if we follow this method to its logical

* Largely based, of course, on the assumption that the roots were final quantities. It is an excellent illustration of the conservatism of science that the discovery that the fibres of the roots could be traced to ultimate regions in the *interior* of the brain has hitherto had absolutely no effect on the classification of the cranial nerves.

extreme, and endeavour to apply it to the peripheral distribution of the fibres, we find that the fibres from one nucleus are distributed to definite tracts, which can be homologised in other forms. Such a method, although it is vastly more logical than the old one, is still impossible of application at the present time, principally because the boundaries of the nerves would be indistinguishable to the naked eye, and could only be limited by the microscope. The seventh nerve, for example, so far from being a definite unit in itself, would be composed of portions of three bundles, and this, of course, introduces practical difficulties which it were better to avoid, even at the expense of some logic. A scientific classification of the cranial nerves, based on the central origin and peripheral distribution of the nerve fibres, is, therefore, at present out of the question, first, on account of the practical difficulties involved, and second, because the anterior nerves require much further investigation based on modern advantages of knowledge and improved methods of research. Before leaving this part of the subject, however, I should mention one respect in which the present system of numbering the cranial nerves is most strikingly inconsistent. When the vertebral theory of the skull was in vogue, it was a matter of no great difficulty so to group the cranial nerves as to make them fall into line with the main postulates of the theory; and, indeed, they support that theory as well as they can be said to support any other. It is, however, a commonplace of vertebrate morphology that Gegenbaur, in his renowned *Hexanchus* paper, completed the overthrow of the vertebral theory by showing that the vagus was a compound nerve, and this, of course, induced him to substitute the segmental for the vertebral theory of the skull. Whether the gill clefts are segmental, and therefore the nerves supplying them of the same significance,

is naturally a much debated point. That cannot, however, be said to affect the cardinal fact that the vagus is a compound nerve. Each of the four branchial divisions of the vagus of a typical Elasmobranch fish is concerned primarily with the innervation of the gill arches immediately before and behind it, and consists of a general cutaneous, "visceral" and pre- and post-branchial branches. Further, I have shown that in *Chimæra*, and also largely in *Torpedo*, each branchial nerve arises separately from the brain. It would be impossible to find nerves more identical both in their central origin and peripheral distribution than the seventh, ninth, and the various branchial divisions of the vagus. If the first two form separate cranial nerves, then the four branchial divisions of the vagus have a perfectly equal right to be ranked with them. And yet the seventh and ninth are considered to be distinct cranial nerves, whilst the last four are lumped together as the vagus. That this was originally due to an error of observation there cannot be the least doubt; but that does not palliate the inconsistency that whilst the error of observation has been corrected, the error of deduction, about which there is no practical difficulty, has been allowed to stand.

The vertebrate head has undoubtedly been produced largely by the development of two series of structures, neither of which series nor their homologues have been found outside vertebrata. These structures are the gill clefts and the lateral sense organs. I use the latter term to include both the epibranchial sense organs (or branchial sense organs) and the lateral sense organs *sensu stricto*. The gill clefts have given us *possibly* the nose cleft, and undoubtedly the mouth and the Eustachian tube; whilst the two series of sense organs have produced probably the nasal organ, possibly the paired eyes (but the phylogeny

of these has yet to be worked out), and undoubtedly the auditory organ. As the existence of both these series constitutes part of the definition of a vertebrate, it follows that they were both represented in that lengthy period during which the vertebrate was becoming evolved out of the invertebrate. And, indeed, it is probable that the sense organs of the epibranchial line, which seem to degenerate before the adult condition is reached, represent some such invertebrate lateral sense organs as are found in the segmental worms of to-day. We must, however, avoid the error of comparing two latter-day structures unless the strongest possible evidence be forthcoming to show that they are genetically related, and we have, let us hope, seen the last of Eisig's comparison of the segmental sense organs of Annelids with the sense organs found in the "mucous" canals of recent fishes. We may, however, classify the cranial nerves according to whether they supply gill clefts or lateral sense organs. Such a classification would have the following form :—

Branchial Nerves or Nerves Supplying Gill Clefts.	Lateral Nerves or Nerves Supplying Epibranchial and Lateral Sense Organs.
Cleft ?	*Olfactorius.* Smelling organ.
Trigeminus. Mouth cleft.	*Opticus.* Paired eyes. Involves also the nerves secondarily developed as the differentiation of these sense organs proceeded. — *Motor oculi.* *Patheticus.* *Abducens.* — Eye muscles
Facialis. Hyoidean, spiracular, or ear cleft.	*Auditorius.* Hearing organ. This nerve may include also the series of nerves that supply the sense organs in the "mucous" canals of fishes.
Glossopharyngeus. First branchial cleft.	
Vagus. Remainder of branchial clefts, of variable number.	

This table ignores the visceral ("collector") division of the vagus, about which there is still considerable uncertainty. It has been supposed to correspond, posteriorly, to the so-called "visceral" branches of the anterior branchial nerves; but this can hardly be the case, since each unit in the vagus possesses a "visceral" branch of normal position and distribution. The morphological value of the visceral division of the piscine vagus, therefore, still awaits elucidation.* Another omission in the table is, of course, the spinal accessory and hypoglossal nerves. The latter is undoubtedly represented in the lower vertebrates, where we see that it is formed by the most anterior spinal nerves which have lost their dorsal roots, and which may or may not pass through the cranium.† The condition of these nerves emphasises the fact, admirably illustrated amongst the "Ganoid" fishes, that the vertebral column has actually played some part in the building up of the skull. The vertebral theory, therefore, though largely false, certainly contained an element of the truth. Hence the hypoglossal nerve, and the spinal accessory also (at any rate, for the most part), belong to a different category from the reminder of the cranial nerves, and should not therefore be ranked with them—if we are to understand by a cranial nerve a nerve related essentially and primitively to the head.

* A possible explanation of the vagus, I think, is that the branchial nerves are secondarily sympathetic, *i.e.*, in function only, whilst the visceral nerve is primarily sympathetic, *i.e.*, represents a modified portion of the sympathetic, and thus both physiologically and morphologically belongs to that system. Its connection with the vagus is thus a "blind," and of precisely the same significance as the connection of the sympathetic with the trigeminus and facialis.

† Cp. the elaborate work recently published by Max Fürbringer ("Festschrift für C. Gegenbaur," Bd. iii.)

No appreciation of the cranial nerves is possible, unless their peripheral distribution is taken into account at the same time, and we thus see that it is possible to trace the phylogeny of the cranial nerves by investigating the evolution of the structures which they supply. We are hence interested to know what has been the phylogeny of the two series of structures enumerated in the preceding table. It is obvious, at the very outset, that both sets of nerves must have been modifications of nerves previously existing, for, to put it briefly, as both the series concerned are obviously modifications of old structures, it follows equally that the nerves supplying these structures must have become adapted to the new conditions. For example, we know that the lateral sense organs have arisen by the differentiation of portions of the surface epiblast, and it hence results that the lateral line nerves are modified somatic sensory nerves. It is, in fact, this change of function that marks the distinction between the invertebrate and the vertebrate, *e.g.*, such a change as has taken place in the phylogeny of a branchial nerve, which, from at one time being partly, if not largely, a somatic nerve, now belongs almost entirely to the visceral system. Just as the nerve "shadows" the maturation of the sense organ, so the brain, which represents a ganglion on a nerve, in its turn develops *pari passu* with the cranial nerves. To say that the "lobus trigemini" of the fishes' brain is simply a part of the brain that happened to become connected with the lateral line nerves, is to be unphilosophical at once; but to state that the "lobus trigemini" has been produced to meet the growing exigencies of the lateral line nerves, which themselves owe their existence to the spreading of the sense organs, explains immediately all the structures concerned. The archaic brain and cranial nerves were but the servants of the sense organs, and it is doubt-

less easy prophecy to foretell that he who discovers the phylogeny of the sense organs will have solved the more important problems involved in the evolution of the vertebrate head. The visceral system and its nerves present independent difficulties, which the study of the branchial nerves has hitherto done little to dispel.

The old view that the head was a modified part of a uniform body naturally produced many attempts to homologise the cranial with the spinal nerves. The necessity of reducing the cranial nerves to a number of metameric structures, each having representatives of dorsal and ventral roots, resulted in the publication of many theories, often mutually destructive, but some of great ingenuity. The whole discussion completely begged the fundamental question that the cranial nerves *were* modified spinal nerves, and the view that both might have totally different phylogenetic histories was hardly contemplated or provided for. We now find that these attempts are ceasing, and that morphologists are beginning to realise that the cranial nerves cannot be serially compared with the spinal nerves. The apparent conclusiveness which formerly characterised their efforts is another illustration of how easy it is to compare one structure with another, and how often it transpires that such comparison is absolutely without value. The essential difference that exists then between cranial and spinal nerves, and the futility of all efforts to show that they are essentially serial in character, may and has been explained as due to either of two causes. One is that the head is phylogenetically the older portion of the vertebrate organism, and the other the opposite view that it represents the younger portion. In either case, the absolute distinction that exists between cranial and spinal nerves is, of course, explained; but, to my mind,

neither hypothesis is at all in harmony with the facts. Both explanations ignore a third much simpler one, that the anterior extremity of the primitive form must have infallibly differed sufficiently from the middle region to explain any difference between cranial and spinal nerves. And such a difference would, of course, be considerably emphasised by the production of such distinctively vertebrate characters as gill slits and lateral sense organs, the growth of both of which would, as has been previously pointed out, involve marked changes in the brain and anterior or cranial nerves. In a sense, the view that the head is younger than the body is certainly true, if we overlook the fact that it represents the modified anterior extremity of the primitive form. For these modifications have been so great that they largely constitute the difference between vertebrates and invertebrates. The metamerism of the body is a well-marked invertebrate character that is lacking in the head. Further, such structures as gill arches and lateral sense organs, being distinctively vertebrate characters, are necessarily "new." This has been well shown by Ayers to be the case with the vertebrate auditory organ, which we now know has been evolved within the vertebrate series, is therefore a characteristically vertebrate structure, and must have taken a considerable part in the production of the head. In this connection *Amphioxus* is very interesting. It possesses a well marked and modified anterior extremity, but the condition of its notochord, somatic muscles, and nervous system, distinctly shows that it has no head properly so-called, and it seems to me that some such condition as this probably characterised the anterior extremity of the primitive vertebrate. We may therefore conclude that the cranial nerves, *as such*, are phylogenetically younger than the spinal nerves; or, to put it another way, the

anterior or cranial nerves have been constantly undergoing modifications, whilst the posterior or spinal nerves have, relatively speaking, remained fairly constant.

We have now to enquire into the essential nature of the lateral and branchial nerves, and to ascertain, if possible, the bearing their structure has upon the problem of the phylogeny of the head. Omitting the eye-muscle nerves, which are the least primitive of the cranial nerves, and involve altogether special problems, and also the first and second pairs, of which much has still to be learned, we may consider the auditory and its associated nerves first, as it is on these nerves that recent investigation has been most prolific and most successful. And here we at once see that the metameric incubus has weighed heavily on the shoulders of advancing knowledge. It is, in fact, only within the last few years that this retarding influence has been shaken off, and the investigator has been free to follow where the majority of the facts undoubtedly led him. The older morphologists naturally regarded the auditory and lateral sense organs as forming a series of metameric structures, and it was hence incumbent on them to show that their innervation was also metameric. The structures concerned being sensory organs, a number of nerves had to be found which would correspond to the dorsal sensory branches of the spinal nerves. It is, perhaps, superfluous to remark that these nerves were found, and we meet with descriptions of two dorsal branches of the trigeminus, two of the facial, one of the glossopharyngeal, and a variable number for the vagus. And here it may be observed that the ground was at first almost entirely worked by embryologists, and great as the work of such renowned morphologists as for example Dohrn and Alexander Goette undoubtedly was, it is in this connection to be

regretted that some sound anatomical work was not initiated to check and extend the results obtained by embryological research. Had this been done, I think few will doubt that much error would have been avoided. However, pioneer work from an anatomical point of view was done by Friant and Allis, who first showed that, as far as the adult was concerned, the fifth nerve took no part in the innervation of the sense organs—a similar conclusion having been reached at about the same time by the embryologists Marshall and Spencer. Hence began the tacit controversy between anatomists and embryologists, both of whom held totally different views as to the innervation of the sense organs of the lateral line. Recently the exclusion of the trigeminal nerve from participating in the innervation of the system has been followed by the elimination (anatomically) of the glossopharyngeal—the nerve from the latter formerly supposed to supply certain of the sense organs of the line having been found on investigation to arise from the so-called lateralis nerve (vagus), and only to accompany the glossopharyngeal. And with regard to the lateralis itself, it is difficult to see how there could ever have been any doubt about it. A careful dissection of its root in a number of the more primitive fishes invariably reveals the fact that it arises both above and in front of the roots of the glossopharyngeus and vagus proper, and hence on anatomical grounds is no more a branch of the vagus than it is a branch of the glossopharyngeal. It is further seen to arise from about the same region as the other lateral line nerves, and the further important discovery, initiated by Mayser, and ably followed up by Strong, that the lateral line nerves arise from a common centre in the brain, establishes as a fact the contention that the lateral line nerves form an independent system by themselves.

Briefly stated, the lateral line nerves, from being at first considered metameric in character, and formed by the dorsal branches of the various cranial nerves, have now been proved to be entirely independent, and absolutely unconnected with *any* of the cranial nerves. From an anatomical point of view the lateral nerves are altogether *special modifications* that have advanced *pari passu* with the spreading of the organs which they supply, and are just as independent and distinctive as the sense organs themselves. They have their own centre in the brain, the tuberculum acusticum, their own brain lobe, the "lobus trigemini," and their own characteristic nerve fibres, which are larger than any other nerve fibres known. We have a precisely parallel case in the electric battery, electric nerves, and electric lobe of the Torpedo. So far, then, we have not been dealing with nerves which it is possible to arrange in a definite number of pairs or portions of pairs, but with a well-defined single system, whose origin in the brain and ultimate course is a matter of physiological convenience only, and has no relation to any formal plan.

In the meantime the embryological evidence was slowly veering round so as to fall into line with the anatomical position. This movement was initiated by H. V. Wilson and Mitrophanow, who showed that the auditory organ and lateral line organs proper arose from a common sensory anlage, the differentiation of which, backwards, forwards, and internally, produced the two series of sense organs in question. Here was another proof of the unity of the lateral organs and of their original limited distribution, as well as confirmation of the collateral question of the derivation of the auditory organ from lateral sense organs so conclusively put by Ayers. Further, there is more than a suspicion that embry-

ologists have hitherto been following a Will-o'-the Wisp, and that the sense organs they have been tracing do *not* become the lateral sense organs of the adult. This, as an error of interpretation, would certainly be welcome news if true, since it is difficult to conceive that so many eminent morphologists should have been mistaken in their facts, and it would, of course, at once explain why the anatomical and embryological views should have been so widely different. It is stated that the sense organs described by embryologists belong to an altogether different system, which is perhaps metameric, which possibly corresponds to the segmental sense organs of invertebrates, and which degenerates in the adult. It is, therefore, very probable that the development of the lateral organs, when described, will be found to exactly tally with their adult relations, and to conform with the views previously stated.

In the branchial nerves it is obvious that we have more primitive structures than is the case with the lateral nerves, since they represent the modified nerves of the anterior extremity of the ancestral form, and have undergone far less differentiation both as regards bulk and nature. The lateral nerves cannot have been represented in the archaic vertebrate by more than a few bundles of somatic sensory fibres, for the majority of the fibres of the anterior nerves went to form what we now know as the branchial nerves. That the branchial nerves represent modifications of the primitive type follows as a logical necessity, but the modification was perhaps more physiological than anatomical, and consisted rather in the differentiation of fibres than in the formation and arrangement of nerve trunks.

A visceral arch of a fish is supplied by one afferent vessel, drained by two efferents, and innervated by two

nerves. The occurrence of the blood vessels is readily explicable, but why one arch should be supplied by two nerves, when a compound trunk would serve the purpose equally well, is a matter which does not seem to have been much thought about. Then again, a branchial nerve is not confined to the supply of one arch, but sends branches to parts of two. The distribution of these branches at once suggests that the gill arches are intersegmental, *i.e.*, if the branchial nerves themselves are segmental. But however this may be, each branchial nerve consists of at least two parts, which are morphologically as distinct from one another as the fifth nerve is from the seventh. A third division, which is often but not invariably present, is concerned largely with the skin of the back. It would be an interesting enquiry to determine, in the light of recent investigation into the nature of branchial nerves, why the latter fork over a cleft and not over an arch. This, as above stated, is at once explained if the arches were developed intersegmentally, but it assumes that the nerves themselves are segmental (which is, however, possible enough), whilst it may also be explained, in virtue of the compound nature of the branchial nerves, by the fusing of contiguous bundles of nerve fibres—one sensory and the other motor. This, on account of the completely distinct character of the main components of a branchial nerve, seems to me to be the more probable view, but such a view necessarily makes the solution of the problems concerned more difficult than might at first have been supposed.

A typical branchial nerve (by which I mean one that includes a somatic sensory component) arises from three nuclei in the brain—from the "motor nucleus," "the spinal fifth tract," and the nucleus of the fasciculus communis system. Leaving out the more specialised tri-

geminal nerve, these three centres give origin to the fibres of the three distinctively branchial nerves—the seventh, ninth, and tenth. Each of these nerves, apart from the somatic sensory fibres from the spinal fifth tract, belongs essentially to the visceral or sympathetic system. The fibres from the spinal fifth tract are given off from the root of the nerve immediately outside the skull (but sometimes intracranially) and pass to the skin of the back, where, as before stated, they function as somatic sensory nerves. The remainder of the fibres from the other two tracts form the trunk of the branchial nerve, and just over the visceral cleft are placed two ganglia (which, as a rule, apparently form a single mass), one ganglion for each set of fibres. Arrived at the cleft, the branchial nerve, according to the old view, was supposed to divide into three bundles—one supplying the lining of the pharynx, one passing along the posterior edge of the arch in front of the cleft, and the third skirting the anterior edge of the arch behind the cleft. This distribution of a branchial nerve has been made use of to prove that there were primitively no gill clefts between the mouth and the first branchial cleft, since the facial nerve forks over the spiracular cleft, gives off a palatine branch corresponding in every respect with the visceral branch of a posterior branchial nerve—the remaining two bundles entering into pre- and post-branchial relations with the mandibular and hyoid arches respectively, thus showing the improbability of any arch ever having existed between these two. With regard to the division of the branchial nerve into three bundles, the facts are as follows:—The trunk consists, as has been previously described, of two bundles—a visceral motor bundle from the motor nucleus, and a visceral sensory bundle from the fasciculus communis system. The latter passes downwards and divides to form

the visceral and pre-branchial (pre-trematic) branches of the nerve, whilst the motor fibres form entirely the post-branchial (post-trematic) branch. This can, to an extent, be verified by dissection, when it is found that only the fibres of the post branchial nerve can be traced into the muscles of the gill arches (cp. Allis's last *Amia* paper*). Both pre- and post-branchial nerves are, as a rule, continued beyond the gill bearing portions of the arches on to the floor of the pharynx, and it is these branches of the piscine branchial nerve which undoubtedly have formed the lingual branches of the posterior cranial nerves of the higher vertebrates.

The pre-branchial nerve, therefore, is a visceral sensory nerve, and the post-branchial a visceral motor nerve, both belonging essentially to the sympathetic system. It is now easy to see why each arch should be supplied by two nerves, since both bundles differ essentially in nature—the branch edging the anterior surface of the arch being motor and that coursing along the posterior edge sensory. Both bundles, although they accompany one another for a time, are absolutely distinct in every other respect, so much so that it appears to me probable they originally pursued different courses, and that each visceral arch was supplied by two independent nerves.

We have seen that it is unphilosophical, at present at any rate, to arrange the cranial nerves into a fixed number of serially occurring pairs, and that even in the case of the branchial nerves, where the serial arrangement is most marked, it would be hazardous to definitely assert that each branchial nerve represented a metameric unit. That the cranial nerves form an association of structures whose present form is due practically to physiological necessities, and not to a survival of an originally formal serial arrange-

* Jour. Morph., 1897.

ment, is admirably shown by an examination of the lateral line nerves of fishes. In the Holocephali, which we know palaeontologically to represent archaic forms, and therefore, perhaps, show us the nerves in a fairly primitive condition,* the lateral line nerves arise from a series of independent roots, which, in only one case, are confused with the roots of any of the other nerves. The facts, therefore, here go to show that the lateral sense organs are supplied by a number of nerves, which, being entirely confined to this purpose and almost entirely distinct from the remaining cranial nerves, we cannot conceive as existing apart from the sense organs themselves, and, indeed, only as a few somatic sensory fibres confined to the region from which the lateral sense organs were primitively differentiated. An examination of other forms shows that the condition in the Holocephali represents only the first chapter of the tale, the last being, as illustrated by the specialised Teleosts, the condition in which the lateral line nerves have become completely incorporated with one of the remaining cranial nerves, notably the facial. We may infer that the Holocephalous type is the more primitive one, because Palaeontology teaches us that as regards their skeletal structure they have departed less from their Palaeozoic ancestors than the specialised Teleosts. Hence we have two extremes—a primitive extreme, in which the lateral line nerves arose separately from the brain and formed four independent nerves; and a specialised extreme, in which these four nerves have finally become more or less fused with the seventh or facial nerve. If we

* But how far is it permissible to take a series of *recent* forms, arrange them in a certain order, and then claim that they represent stages between one type and another? All recent forms are ultimate products and not stages, and how are we to know that certain of them are slightly more primitive than others? The only *direct* evidence is based on the preservation of *hard* parts.

examine intermediate types, we find every gradation between these two extremes—most of them amongst the archaic Elasmobranchs. The first of the lateral line nerves to lose individuality is the external mandibular, the buccal follows, then the superficial ophthalmic, and finally the lateralis. (This sequence is, of course, somewhat arbitrary, but it possibly represents what actually happened.) Simultaneously with this concentration of the lateral line nerves is to be noticed a concentration and diminution in the lateral sense organs themselves. Primitively, the lateral line nerves are not in any sense serial, nor do they conform with any formal scheme; latterly they are even less so, and their concentration simply shadows, and is an expression of, the decline and fall of the structures which they supply. The whole of the facts go to show that the position and course of the cranial nerves has been determined by physiological necessities, and that their arrangement into any formal scheme is, at the present, purely artificial.

The series of lateral sense organs, enclosed in the "mucous" canals, forms an apparatus the tendency of which in the specialised fish is to be reduced or even lost. It is found in its most fantastic and prolific form in the cartilaginous fishes, and thence upwards it becomes, by an elimination of the last added details, naturally resolved first into the fundamental type, which then itself begins to disappear. In the various stages of their decline, the sensory canals pass through some curious vicissitudes. The sense organs in the canals are lost first, and then the canals, being apparently functionless, often exhibit some remarkable distortions. The dermal tubules become reduced in number, lose their openings on to the surface, and often become vesicular. The canals themselves often become ampulliform or vesicular, and may, in apparently

their last stages, be represented by a more or less simple tube having as few as one or two openings on to the surface on each side. In many forms the whole system is simply a caricature of its robuster form in the cartilaginous and less specialised bony fishes—all the degenerate forms occurring amongst those Teleosts which, for various special reasons, have undergone most adaptation.

That the lateral sense organs existed at one time as functional organs on the surface of the body necessarily follows from their origin and development. Ayers is inclined to think that those recent forms in which it is still superficial have been produced by a retrogressive development from the canal type, but I am not disposed to admit that the evidence favours this view. However that may be, recent work on the development of the system in Elasmobranchs and Teleosts seems to show that it was at first very confined and entirely limited to the auditory region. From thence it spread (still on the surface) forwards and backwards, producing by division in front the usual tracts, and thus laying down a fundamental plan, from which the canals were subsequently elaborated. This plan included the tract over the eye, that under the eye, another in relation to the lower jaw, and finally one at the side of the body. The architecture of the system having been determined, canals were then differentiated. Each sense organ sank below the surface, so that it came to lie in a longitudinal furrow. The lips of the furrow then fused, but left anterior and posterior apertures, with the result that each sense organ lay in a short longitudinal closed canal, open, however, at each end. These canals approximated, fused end to end; and thus formed a continuous longitudinal canal. Two contiguous primitive apertures fused to form a larger pore, and subsequent sinking on the part of the canal produced

a tube of variable length in connection with this pore—thus giving rise to a dermal tubule. One sense organ, therefore, should be placed between adjacent tubules. I have discussed elsewhere the metamerism of this system of sense organs, and have, I think, shown that the facts are entirely against such a view. The only evidence of metamerism is found in the body canal, where in many, if not in most, forms the sense organs occur metamerically. This, however, I have shown to be a secondary development. On the head the lateral sense organs are certainly not metameric. With regard to the auditory organ, few can now doubt that it is a differentiated portion of the lateral line system. Concerning its mode of development, the facts are not so conclusive. Ayers ably contends that the semicircular canals represent portions of lateral canals, and have therefore always been present during the phylogeny of the ear. I have, in the work previously alluded to, ventured to join issue with him on this point, and have expressed the belief that the auditory organ was primitively a sac from which the semicircular canals were subsequently differentiated.

DESCRIPTION of SOME SIMPLE ASCIDIANS COLLECTED in PUGET SOUND, PACIFIC COAST.

By Prof. W. A. Herdman, D.Sc., F.R.S.

With Plates XI. to XIV.

[Read May 13th, 1898.]

In a previous paper in this volume ("Transactions," p. 84) I have recounted the circumstances under which I enjoyed a few days dredging and shore collecting about Port Townsend, in Washington State, and Victoria, British Columbia, in September, 1897. In that paper preliminary lists of the species obtained in all groups were given; and the Copepoda were more fully described by Mr. I. C. Thompson and Mr. Andrew Scott. The remaining Crustacea will be dealt with in a separate paper by Mr. A. O. Walker (see p. 268); while, in the present paper, with the help of Miss J. H. Willmer, I shall describe the Tunicata, several of which are new to science. In this way we hope to have all the papers to be published at present in regard to this little collection of marine invertebrates from Puget Sound printed together in the same volume of our "Transactions," a matter of no little convenience to those desiring to refer to these faunistic papers.

All the Tunicata described are simple Ascidians, and they represent nine species belonging to seven genera; five of them are new, and the remaining four are all interesting forms important for comparison with allied European species, and two of them insufficiently known.

I have already in the previous paper (this vol., p. 89) drawn attention to the resemblance between the marine fauna of Puget Sound and that of North-West Europe—say the British and Scandinavian coasts. I think it may with truth be said that all the Ascidians I obtained in this arm of the North Pacific are closely related to familiar species on our own North Atlantic coasts. I can draw up parallel series* as follows :—

PUGET SOUND.	NORTH ATLANTIC.
Chelyosoma productum, St.	*Chelyosoma macleayanum*, Brod. & Sower.
Corella willmeriana, n. sp.	*Corella parallelogramma*, O. F. Müll.
Ascidiella incrustans, n. sp.	*Ascidiella* (?) *depressa*, Ald.
Ascidiella griffini, n. sp.	*Ascidiella aspersa* (var. *pustulosa*), O.F.M.
Cynthia haustor, St.	*Cynthia squamulosa*, Ald.
Cynthia villosa, St.	*Cynthia echinata*, L.
Styela gibbsii, St.	*Styela rustica*, L.
Styela joannæ, n. sp.	*Polycarpa* (? *Styela*) *finmarkiensis*, Kiær.
Molgula pugetiensis, n. sp.	*Molgula septentrionalis*, T.

This, taken along with the similarity between the two faunas shown in other groups, suggests the possibility that there is a common northern circum-polar marine fauna which sends extensions southwards on the western coasts of Europe and America.†

I notice, with much interest, in the current number of "Science" (No. 172, p. 540) that at the meeting of the New York Academy of Sciences held on March 14th,

* I believe Mr. Walker will show similar series for the Crustacea.

† See also Mr. Walker's remarks in regard to Crustacea, this vol., p. 270.

Mr. Bradney B. Griffin,* of Columbia University, reported on the Nemertina collected by himself during the previous summer in Puget Sound and Alaska, and commented upon "the occurrence of closely related though distinct species on the west coasts of both Europe and North America."

Dr. John Murray has in recent years propounded the view† that the marine faunas towards the poles are genetically more closely related to each other than to any intervening fauna; and he supports this "bipolar" hypothesis by quotations from the reports of some of the specialists who described the "Challenger" collections. I do not know how it may be with other authors quoted, but in my case the series of short extracts given from my report require to be expanded and explained, and are then seen not to give Dr. Murray's view the support which he supposes. My remarks, on p. 265 of the Report, which he quotes, refer only, it may be stated, *to "Challenger" species.* In the genus *Styela,* for example, there are plenty of species known from the tropics. Dr. Sluiter has described about fifteen species from the island of Billiton, between Singapore and Java.

I consider that the distribution of Tunicata as a whole does not lend any support to the bipolar hypothesis. On account of the admitted want of equivalence between the characters made use of in specific and generic diagnosis in the different groups mere lists may be deceptive, especially if drawn up and correlated by one man, who cannot

* I am exceedingly sorry to see also a brief notice of Mr. Griffin's untimely death on March 26th. He was a promising young investigator whose death is a loss to Zoological Science. I had the pleasure of being accompanied on my dredging expedition at Port Townsend last September by Mr. Griffin, and was struck by his earnestness and devotion to work.

† "Challenger" Report—Summary of Results, p. 1440, &c., and Trans. R.S. Edin., vol. XXXVIII., p. 344, &c.

possibly be a specialist on all groups of marine invertebrata. For that reason I now abstain from expressing any opinion except in regard to the group of which I have a more intimate knowledge. It seems to me that this matter must be settled by specialists in each group of animals stating their opinions as to the genetic affinities of the northern and southern faunas in their own groups quite apart from and uninfluenced by general lists containing other groups. The Tunicata instanced by Dr. Murray, both in his "Challenger Summary" and in his paper on the "Marine Fauna of the Kerguelen Region," help to swell lists that assume rather imposing dimensions, but when I examine the case of these species and genera of Tunicata individually, I find that the records of occurrence have to be added to or modified in such a way as to entirely change the nature of their evidence, and show that there is no such close resemblance between the northern and southern polar faunas as Dr. Murray and others have supposed.

In 1864 Stimpson published a brief account of some new simple Ascidians obtained from Port Townsend and other localities in Puget Sound. His list is as follows :—

Chelyosoma productum, St.; *Cynthia haustor*, St.; *C. gibbsii*, St.; *C. coriacea*, St.; and *C. villosa*, St.

I believe that I also obtained all these species, except, perhaps *Cynthia coriacea*,* and in addition I collected five other species which are new to science. Stimpson's species were, however, so briefly described, without figures, that they can scarcely be said to be *known* to science. Dr. von Drasche, in 1884, re-described and figured *Chelyo-*

* Which I would suggest may possibly be merely a variation of *Cynthia haustor*, a very common and somewhat variable species. The name *coriacea* was pre-occupied by *Cynthia coriacea*, Ald. and Hanc., 1848, and so must lapse in any case.

soma productum and *Cynthia haustor* from Puget Sound, and I shall now perform the same very necessary office for *Cynthia villosa* and *C.* (really *Styela*) *gibbsii.* The remaining species are here described as new.

The specimens of this collection have all been examined in the first place by Miss Willmer, who has kindly prepared for me the microscopic slides from which I have drawn up the descriptions which follow, and from which I have prepared the figures in the accompanying plates. Every specimen has, however, been examined by myself, as well as by Miss Willmer.

The types of the new species, along with the rest of the collections from Puget Sound, have now been deposited in the Museum of Zoology in University College, Liverpool.

Chelyosoma productum, Stimp.

This species was described by Stimpson in 1864, from specimens obtained off the N.W. point of Lummi Island, Puget Sound. It has since been re-described and figured by von Drasche. His specimens were from Port Townsend.

I dredged two large specimens in Puget Sound—one in Scow Bay, opposite Port Townsend, adhering to a mass of *Cynthia haustor* and *Styela gibbsii*, and the other attached to a mass of Sponge and Zoophytes dredged off Victoria, B.C., at a depth of 5 fathoms.

I have nothing special to add to von Drasche's description.

Corella willmeriana,* n. sp. Pl. XI., figs. 1—4.

External appearance. Shape ovate, or flattened pyri-

* I have much pleasure in naming this species in honour of Miss J. H. Willmer who has for several years very kindly assisted me in examining large numbers of Ascidians at University College, Liverpool, and who is now a very competent investigator of Tunicate anatomy.

form, with the wider end posterior, and attached by a small process in the middle of the posterior end. Apertures both near the anterior end, not far apart, both distinctly lobed. Surface very smooth and glistening. Colour clear glassy grey. Length 5 cm., breadth 4 cm., thickness, 2 cm.

Test moderately thick, gelatinous, semi-transparent, the alimentary canal showing through.

Mantle very thin, with scarcely any musculature visible except at the anterior end just around the bases of the siphons.

Branchial sac large, very thin and delicate. Internal longitudinal bars numerous and very wide. Their internal edges thickened, especially opposite the connecting ducts, but no papillæ present. Transverse vessels narrow and not distinctly marked. The stigmata form rather irregular spirals of different sizes and shapes.

Many red pigmented cells are scattered throughout both mantle and branchial sac.

Dorsal lamina forming a series of triangular languets.

Tentacles long and tapering, 28 in number, with the same number of much smaller ones alternating with the larger.

Dorsal tubercle straight, transversely elongated, not curved. Slit irregular, approaching a crescentic form.

Visceral mass large, but only occupying the posterior one-third of the left side.

Locality: Port Townsend, 3 specimens.

This handsome *Corella* (Pl. XI., fig. 1) appears to be new. It was of a bright crystalline appearance flecked with red pigment when alive. From *Corella larvæformis* and *C. ovata*, it differs in shape; from *C. minuta* and *C. novaræ*, in the number of tentacles; from *C. eumyota*

and *C. japonica*, in the condition of the mantle, and the form of the alimentary canal, dorsal tubercle, &c. That leaves the common British species *Corella parallelogramma* and the Arctic form *C. borealis*, described by Traustedt from the Kara Sea, and these are certainly the nearest relations of our North Pacific species. From *C. parallelogramma*, however, our form can be distinguished by the almost complete absence of muscles in the mantle, and by the greater irregularity of the branchial sac (fig. 3) and the form of the dorsal tubercle (fig. 4); while from *C. borealis* (which it is most like) it differs in the external shape, the proportions of the alimentary canal (fig. 2) and the greater irregularity of the branchial sac. It is impossible in considering the characters of this series of *Corella*, to avoid the conclusion that these last three, *C. parallelogramma*, *C. borealis*, and *C. willmeriana*, are representative species, and that the Kara Sea form is intermediate in some respects between the British and the Northern Pacific species.

The branchial sac of our specimen contained several specimens of the parasitic Copepod *Doropygus pulex*, Thorell, which have been kindly identified for me by Mr. I. C. Thompson.

Fig. 1, on Pl. XI., shows the single specimen of *C. willmeriana* from the left side, natural size. Fig. 2 shows the alimentary and reproductive viscera from the right side, slightly enlarged. Fig. 3 shows a part of the branchial sac from the inside; and fig. 4 shows the dorsal tubercle, and some of the tentacles and dorsal languets. At the anterior end of the branchial sac the internal longitudinal bars become irregular and incomplete, and are then found as simple or bifurcating buds growing out from the transverse vessels of the branchial sac.

Ascidiella incrustans, n. sp. Pl. XII., figs. 4—6.

External appearance. Body very much depressed, so as to be of flattened scale-like form, and attached by the whole of the under surface. Apertures both on the upper surface, moderately far apart. Surface slightly rough all over. Colour yellowish grey. Length 3·5 cm., breadth 3·5 cm., thickness 5 mm.

Test thin, semi-transparent, highly vascular.

Mantle thin, musculature fairly strong, chiefly transverse.

Branchial sac plicated. Internal longitudinal bars rather wide, papillated at the angles of the meshes. Transverse vessels alternately large and small, with an occasional much larger one. Meshes almost square, and containing about 7 stigmata each.

Dorsal lamina a plain membrane with strong transverse ribs.

Tentacles slender, three sizes, closely placed, about 50 in all.

Dorsal tubercle, simple, horseshoe shaped, with the opening between the pointed horns anterior. The nerve ganglion lies close behind the tubercle. The pre-branchial zone is papillated.

Locality: Off Port Townsend, Puget Sound.

This species recalls at once the European *Ascidia depressa*, and some flattened spreading individuals of *A. plebeia*, but it differs from both these species in several particulars.

Fig. 4, on Pl. XII., shows this species in surface view, natural size; fig. 5 shows the simple dorsal tubercle in the papillated pre-branchial zone; fig. 6 is a part of the branchial sac from the inside, magnified.

*Ascidiella griffini,** n. sp. Pl. XII., figs. 1—3.

External appearance. Shape ovate, with the rounded posterior end broader than the anterior, and the ventral edge more convex than the dorsal. Attached by a small area on the middle of the left side. Apertures both on prominent siphons, branchial terminal, atrial a little way down dorsal edge, both directed forwards. Surface minutely roughened all over, with slightly larger processes round the apertures. Colour warm brownish grey, with a few rust-coloured markings. Length 6 cm., breadth 4 cm., thickness 2 cm.

Test of a soft cartilaginous consistency. Large vessels ramify on the left side.

Mantle fairly thick. Musculature well developed.

Branchial sac plicated. Transverse vessels not all the same size, but not regularly arranged. Meshes much elongated transversely, and containing about 12 rather slender straight stigmata. There are large blunt papillæ at the angles of the meshes, and also smaller intermediate ones. No horizontal membranes divide the meshes.

Dorsal lamina with well-marked transverse ribs and a toothed edge.

Tentacles long and slender, very closely placed, 60 to 70 in number, and of different sizes.

Dorsal tubercle horseshoe shaped or cordate, with both horns turned inwards. The nerve ganglion placed close behind the tubercle, the pre-branchial zone papillated.

Alimentary canal large, occupying at least four-fifths of the left side, imbedded in the reproductive and renal masses.

Locality: Off Port Townsend, Puget Sound, three specimens.

* I dedicate this species to the memory of Mr. B. B. Griffin, of Columbia University, New York, who kindly accompanied me on my dredging expedition at Port Townsend.

This species, in its appearance, recalls that variety of *Ascidiella aspersa*, O.F.M., of European seas, which Alder and Hancock described as *Ascidia pustulosa;* the present species differs, however, in the papillæ on the branchial sac and other particulars.

Fig. 1, Pl. XII., shows *Ascidiella griffini* from the right side, natural size; fig. 2 gives the dorsal tubercle and neighbouring parts, magnified; and fig. 3 is a small part of the branchial sac from the inside, showing the unusually wide meshes and the large papillæ.

Cynthia haustor, Stimp. Pl. XIV., figs. 1 and 2.

This species was very briefly and insufficiently described by Stimpson* in 1864, but since then von Drasche has re-described† the species with all necessary detail.

Our specimens, of which we have over 130, agree perfectly with v. Drasche's description and figures. That author speaks of the individuals adhering together in masses, but he figures only a solitary individual. The aggregated habit is, however, quite characteristic of the species, and by far the majority of the many hundreds I dredged in Puget Sound, both at Port Townsend and off Victoria, B.C., were attached in masses of about twenty individuals on the average. Some of the large masses dredged up in Scow Bay, and which I was unable to bring away because I had no vessel large enough to put them in, must have contained several times that number of individuals. I give here a couple of figures (Pl. XIV., figs. 1 and 2), showing the general appearance of these masses of adhering *Cynthia haustor*. Occasionally other species of Tunicata, *Chelyosoma productum* and *Styela gibbsii* are found attached to the masses.

* Proc. Philadel. Acad., U.S., 1864, p. 159.

† Denkschr. K. Akad. Wiss. Wien, 1884, p. 372.

Cynthia villosa, Stimp.* Pl. XII., figs. 7—11.

This species was very briefly described in 1864 by Stimpson from specimens obtained off Lummi Island and also at Port Townsend in Puget Sound, the exact locality where I dredged the present specimens. Although Stimpson does not sufficiently describe the species, still his account of the appearance agrees so well with my specimens, that I have no hesitation in referring them to his species *villosa*, which I take this opportunity of re-describing. Stimpson's description was as follows:—

"Of similar size, and allied to the *Cynthia echinata* of the North Atlantic, of which this is the analogue or representative species on the west coast. It is, however, easily to be distinguished from that species by the character of the villosity or short hair-like processes with which the test is covered. These are shorter, more numerous than in *C. echinata*, and not provided with radiating hairs at the summit, being simply tapering to a fine extremity, and sparsely pubescent on their sides.

"The base of attachment in this species is very small, and the test at that point is produced into a peduncle, which is sometimes as long as the body is thick. This peduncle is, however, entirely similar to the test in character, and not at all like that of Boltenia. Our largest specimen is about 0·6 inch in diameter.

"Port Townsend, . . and N.W. end of Lummi Island, &c."

The species has apparently not been found since Stimpson's time, unless the spiny form which Traustedt described from the Kara Sea in 1886, under the name of *Cynthia echinata*, can be referred to the present species. They certainly agree in many points, and Traustedt's species is nearer to *C. villosa* than to the true *C. echinata*

* Proc. Philadel. Acad., U.S., 1864, p. 160.

(L.), but the spines are distinctly different in form and arrangement in Traustedt's figure from what our specimens show, and so the two are probably best regarded as closely allied representative species.

There are now five allied, somewhat similar, echinated Cynthias known to me, which form a group extending over most of the world, from the Arctic regions to Australia, and found in both the Atlantic and the Pacific. They are:—

1. *C. echinata* (L.), in North-West Europe.
2. (?) *C. echinata* (L.), Traustedt, in Kara Sea, Arctic.
3. *C. villosa*, Stimp., in Puget Sound, N. Pacific.
4. *C. hilgendorfii*, Traust., in Japan.
5. *C. spinifera*, Herdm., in Port Jackson, Australia.

Cynthia castaneiformis, v. Dr., is another allied form; while *Ascidia* (? *Cynthia*) *spinosa*, Q. and G., *Ascidia villosa*, Fabr., and *Cynthia villosa*, Kupf., are very doubtful species, in regard to which we have not sufficient information.

Alder, in 1863, first pointed out the remarkable fact that the stigmata in the branchial sac of *Cynthia echinata* have their long axes transverse in place of longitudinal, so that they run at right angles to the folds and internal longitudinal bars, in place of parallel to them as in nearly all Ascidians. This peculiar condition of the branchial sac is found in the first three of the above-named species, while in *C. hilgendorfii*, from Japan, and *C. spinifera*, from Australia, the stigmata are normal.

It is clear that the form from the Kara Sea, described by Traustedt in 1886 as *C. echinata* (L.), is distinct from that species. His description does not agree with his own diagnosis (which was correct) of *C. echinata* given in 1880 from Danish specimens. Six branchial folds, 12

tentacles, and a plain dorsal lamina are characteristic of the true *C. echinata*, while the Kara Sea form has 7—9 folds, 15 to 25 tentacles, and a series of dorsal languets in place of a lamina—all points of agreement with *C. villosa* from Puget Sound.

The point in which Traustedt's species differs from *C. villosa* is the spines on the outside of the test, which are clearly seen in his figure to be branched in a stellate manner, 7 to 9 large echinated branches arising from a common peduncle or papilla, whereas, in our specimens (7) of *C. villosa*, the echinated spines are not branched, and so have no stellate appearance.

I shall now give a re-description of Stimpson's species, drawn up from my specimens dredged in the original locality :—

External appearance. Shape ovate, pyriform or cordate, with the narrower end posterior, and sometimes attached by a short stalk. Apertures both anterior, rather far apart, both 4-lobed. Surface closely covered with long echinated spines, which spring from small rounded elevations of the test. These spines have no large branches, and are not grouped in a stellate manner. Colour brownish grey. Length 4 cm., breadth 3 cm., thickness 1 cm.

Test thin but tough, smooth and shining on the inner surface.

Mantle not thick, but muscular, especially on the siphons.

Branchial sac with 8 folds on each side. Internal longitudinal bars about 6 to 10 in a fold, and 2 or 3 in the interspace. Stigmata running transversely, consequently no meshes are present.

Dorsal lamina a series of languets.

Tentacles much branched, from 15 to 20 in number.

Dorsal tubercle horse-shoe shaped, horns turned inwards, opening directed anteriorly.

Gonads present on both sides of body.

Locality: Scow Bay, opposite Port Townsend, Puget Sound, 10 fathoms; 7 specimens, along with great masses of *Cynthia haustor*, Stimp.

Finally, I do not think it is possible that *Cynthia castaneiformis*, v. Drasche, from California, can be identical with *C. villosa*. It is, however, closely allied. Kupffer, in 1874 (Zte. Deutsche Nord-polar-fahrt, II., p. 244), re-described the *Ascidia villosa* of Fabricius (Fauna Groenlandica, p. 333) as a *Cynthia*. I am not at all sure that Kupffer's species was the same as Fabricius', and it is clear that Kupffer's is not the *C. villosa* of Stimpson. Whether Fabricius' species is the same as Stimpson's it is now almost impossible to say.

Fig. 7, Pl. XII., shows the exterior of *C. villosa*, St., and fig. 9 two of the spines enlarged; fig. 8 is the body with the test removed; fig. 10 represents the dorsal languets; and fig. 11 part of the branchial sac showing the curious transverse stigmata.

Styela gibbsii, Stimp. Pl. XIII., figs. 1—4.

I refer to this species, described by Stimpson in 1864, under the name of *Cynthia gibbsii*, a series of 13 specimens, dredged in Scow Bay, near Port Townsend, along with *Cynthia haustor*.

Stimpson's description of his *C. gibbsii* is as follows:—

"Body elongated, attached at one end, more or less cylindrical, or somewhat appressed, and, when contracted, half as thick as long. Surface free from encrusting matters, corrugated both longitudinally and transversely; the longitudinal plications are frequently strongest and most regular, but often they are rendered irregular or

nearly obliterated by the transverse ones. The apertures are placed near together at the extremity of the body on slight protuberances, which are probably produced in life into short tubes. Branchial sac with 10 slight longitudinal folds, not lamelliform; filaments at its summit numerous, small, slender, and simple.

"The largest specimen is 1·4 inch in length, and 0·6 in breadth. Port Townsend, . . . and N.W. end of Lummi Island."

The external appearance of our specimens agrees perfectly with that description, and the only doubt arises from the fact that our specimens are a *Styela* with four folds on each side of the branchial sac, while Stimpson mentions ten folds in all, and therefore very properly calls his species a *Cynthia*. If, however, he was mistaken as to the number of folds, or counted in the endostyle and dorsal lamina, then that would account for his number 10, and I am inclined to think this must be the case. Instead then of describing our form as a new species of *Styela* I think it best to regard Stimpson's species of "*Cynthia*" as our *Styela*, and to re-describe it from our specimens, as follows (see Pl. XIII., figs. 1—4):—

External appearance. Body very much elongated, club-shaped, or of narrow oval form with the broader end anterior. Attached by a small area at posterior end. Siphons placed close together at the anterior end, not prominent. Surface deeply furrowed longitudinally and closely wrinkled transversely. Colour yellowish brown, with a greenish tinge in places. Length 5 cm., breadth 1·5 cm., thickness 1 cm.

Test moderately thick, very tough, inner surface smooth and shining.

Mantle thin, but tough; musculature very regular, the longitudinal bands forming almost a continuous sheet. Both siphons distinctly 4-lobed.

Branchial sac with 4 well-developed folds on each side. With 8 to 9 internal longitudinal bars on a fold and about 10 in the interspace. Transverse vessels alternately larger and smaller; there is also a narrow horizontal membrane present dividing the meshes. Meshes transversely elongated.

Dorsal lamina a plain membrane.

Tentacles about 32, closely placed, of different sizes.

Dorsal tubercle prominent, rounded, with a narrow slit-like opening forming a simple ovate figure, with one horn running outwards (see fig. 2).

Stomach elongated, and marked with a large number of obliquely longitudinal folds. Intestine long, with 2 curves (see fig. 3).

Gonads. Two long narrow tubular ovaries on each side, with groups of branched spermatic follicles arranged around the posterior half of each ovary (fig. 3). There are also many small transparent endocarps scattered over the inner surface of the mantle and between the ovaries.

Our specimens contained in the branchial sac several specimens of the parasitic Copepod *Doropygus pulex*, Thorell, both males and females. These were kindly identified for me by Mr. I. C. Thompson, who says they differ in no respect from examples of the same species obtained in British seas. The specimens of *Doropygus* are in their turn infested with a *Vorticella.*

Fig. 1, on Pl. XIII., shows *Styela gibbsii*, natural size; fig. 2 is the dorsal tubercle enlarged; fig. 3 the alimentary canal and reproductive organs; and fig. 4, a part of the branchial sac from the inside, magnified.

*Styela joannæ,** n. sp. Pl. XIII., figs. 5—9.

External appearance.—Shape swollen ovate, approaching globular, attached by a large area on left side, which is expanded at its edge to form a well-marked basal plate. Posterior end wide, anterior end narrower, and bearing both the apertures rather close together. They are both slightly prominent and 4-lobed, so as to have regularly cross-slits. Surface perfectly smooth. Colour whitish grey. Length 2·3 cm., breadth 2 cm., thickness 8 mm.

Test very thin, and semi-transparent, but rather tough. Thicker and stiffer on the left side over the large area of attachment.

Mantle thin, musculature very delicate. Well-marked sphincters on the siphons.

Branchial sac with 4 well-marked but narrow folds on each side. There are about 6 internal longitudinal bars on each fold, and 4 in the interspace. The transverse vessels differ in size—three sizes alternating with fair regularity. Meshes transversely elongated, containing 6 to 8 stigmata, which are rather straight and wide. Meshes occasionally divided by a narrow horizontal membrane.

Dorsal lamina a plain narrow membrane.

Tentacles long and slender, closely placed, about 40 in number.

Dorsal tubercle simple, horse-shoe shaped or cordate, with horns turned in.

Stomach elongated and curved, with many longitudinal grooves. Intestine with a narrow loop.

Gonads in the form of several long slender tubes, 7 on the right side and 8 on the left. A circle of from 30 to 40 minute atrial tentacles is present.

* I venture to name this species after my wife, who accompanied me on the dredging expeditions, and, as usual, gave me much help in collecting, preserving and packing the specimens.

Locality: Port Townsend; one specimen.

This species is closely related to *Polycarpa* (? why not *Styela*) *finmarkiensis*, Kiær, from the north of Norway, but differs in details of dorsal lamina, tentacles, &c.

Fig. 5, Pl. XIII., shows the only specimen from the right side, natural size; fig. 6 is the same from the dorsal edge, to show the adhering area; fig. 7 is a part of the branchial sac from the inside, magnified; fig. 8 shows the alimentary canal and the gonads; and fig. 9 is the dorsal tubercle and nerve ganglion.

Molgula pugetiensis, n. sp. Pl. XIV., figs. 3—7.

External appearance. Shape ovate, transversely elongated, with the dorsal edge narrow and the ventral broader and flatter. Both apertures close together near the ventral edge of the anterior end. Surface covered with fine sand grains, attached to delicate branched hairs. Colour dark grey. Length (dorso-ventral) 2·2 cm., breadth (antero-posterior) 1·4 cm., thickness, 8 mm.

Test moderately thick, but very soft and flexible.

Mantle fairly muscular. Branchial siphon with 6 prominent pointed lobes; atrial siphon square.

Branchial sac with 7 folds on each side. Three or four internal longitudinal bars on each fold. Stigmata long and curved, arranged in large infundibula.

Dorsal lamina a plain narrow membrane.

Tentacles 14, large and small, placed alternately.

Dorsal tubercle of cordate form, with the broader end posterior. Horns not coiled.

Gonads one ovate mass on each side.

Locality: Off Victoria, Puget Sound; 5 fathoms; one specimen.

This is an ordinary-looking *Molgula*, but it does not seem to agree with any previously described form,

although it comes near to *M. occulta*, Kup., and perhaps still more near to *M. septentrionalis*, Traust., from the North of Europe.

Fig. 3, Pl. XIV., shows the exterior, natural size; fig. 4 is the dorsal tubercle and neighbouring parts; figs. 5 and 6 show the right and left sides of the body, with the test removed; fig. 7 is a small part of the branchial sac from the inside, magnified.

Explanation of the Plates.

Plate XI.

Fig. 1. *Corella willmeriana*, n. sp., natural size, from left side.
Fig. 2. Alimentary and reproductive viscera, slightly enlarged.
Fig. 3. Part of the branchial sac, from inside, × 50.
Fig. 4. Tentacles, dorsal tubercle, and languets, × 50.

Plate XII.

Fig. 1. *Ascidiella griffini*, n. sp., natural size.
Fig. 2. Dorsal tubercle of same, × 50.
Fig. 3. Part of branchial sac, × 50.
Fig. 4. *Ascidiella incrustans*, n. sp., natural size.
Fig. 5. Dorsal tubercle of same, × 50.
Fig. 6. Part of branchial sac, × 50.
Fig. 7. *Cynthia villosa*, Stimpson, natural size.
Fig. 8. Same, with test removed.
Fig. 9. Two of the spines from the test, enlarged.
Fig. 10. Dorsal languets, × 50.
Fig. 11. Part of the branchial sac, showing the transversely running stigmata, × 50

Plate XIII.

Fig. 1. *Styela gibbsii*, Stimpson, natural size.
Fig. 2. Dorsal tubercle of same, × 50.
Fig. 3. Alimentary canal and gonads of same, slightly enlarged.
Fig. 4. Part of branchial sac, × 50.
Fig. 5. *Styela joannæ*, n. sp., natural size.
Fig. 6. Same from the ventral edge to show base of attachment, natural size.
Fig. 7. Part of branchial sac, × 50.
Fig. 8. Alimentary canal and gonads of same, × 2.

Plate XIV.

Figs. 1 and 2. Two clumps of *Cynthia haustor*, Stimp., as dredged in Scow Bay.
Fig. 3. *Molgula pugetiensis*, n. sp., natural size.
Fig. 4. Tentacles, dorsal tubercle, &c.
Fig. 5. Same, with test removed, from right side.
Fig. 6. Left side of the same.
Fig. 7. Part of branchial sac from inside, × 50.

CRUSTACEA collected by W. A. HERDMAN, F.R.S., in PUGET SOUND, PACIFIC COAST of NORTH AMERICA, September, 1897.

By ALFRED O. WALKER, F.L.S.

With Plates XV. and XVI.

[Read May 13th, 1898.]

THE collection of Malacostraca made by Prof. Herdman in Puget Sound, on the occasion of his visit to Canada with the British Association, in September, 1897, consists of 33 species, as specified below. Of these the large proportion of 7 appear to be new to science, and of the others 4, viz., *Leucothoë spinicarpa* (Abild.), *Melita dentata* (Kröyer), *Ischyrocerus minutus*, Lillje., and *Podoceropsis excavata* (Sp. Bate) have not, to my knowledge, been previously recorded from the Pacific, so that nearly one-third of the total number of species are new to the fauna of the west coast of North America. This large proportion can only be attributed to the long experience of Prof. Herdman in dredging operations, the trained eye being able to detect small species, as well as to see the difference between similar, but not identical, species in the larger forms.

The geographical distribution of the European species of Amphipoda in the collection presents some interesting points. *Leucothoë spinicarpa* has been found from Green-

land, in lat. 68° 8′ N., long. 58° 47′ W. (Hansen) to the Azores (Barrois). *Melita dentata*, on the other hand, appears to be a strictly northern species, having been recorded from Spitzbergen (Goes), Greenland (Hansen), Grand Manan (Stimpson), Labrador (Packard), and as far south as Denmark (Meinert), the coast of Northumberland (Norman), and Halifax, Nova Scotia (S. J. Smith). It has not been recorded from the West Coasts of the British Isles. *Ischyrocerus minutus* [=*I. isopus* (Walker)] again, which has sometimes been confounded with the nearly allied *I. anguipes*, Kröyer, has been recorded from Baffin's Bay, lat. 72° 8′ N. (Ohlin), and is abundant on the coast of North Wales. I have also a specimen from Valentia, West Coast of Ireland. On the other hand, *Podoceropsis excavata* (Sp. Bate), which is fairly common in Liverpool Bay, and occurs on the French and Norwegian coasts, does not appear to have been recorded on the last named further north than lat. 64° (Sars). Negative evidence, however, in a class of marine animals that has been so little studied, is almost worthless.

Besides the species in the collection that are absolutely identical with British species, the resemblance between others is very remarkable. Thus, *Eupagurus kennerlyi* only differs from *E. cuanensis* in being larger and having the sixth joint of the walking legs relatively shorter. *Crangon affinis* only differs from *C. vulgaris* in being slightly shorter and wider, and closely resembles *C. allmani* in the carinæ of the sixth abdominal segment. Similar slight differences separate the other species in the annexed list from their representatives in the British Seas.

The type specimens are in the Museum of Zoology at University College, Liverpool.

Representative Species.

West Coast of America.	British Isles.
Oregonia gracilis, Dana.	*Macropodia longirostris* (Fabr.).
Scyra acutifrons, Dana.	*Hyas coarctatus*, Leach.
Eupagurus kennerlyi, St.	*Eupagurus cuanensis* (Thompson).
Crangon affinis, De Haan.	*Crangon vulgaris*. *C. allmani*.
C. munitus, Dana. *C. munitellus*, Walker.	*C. fasciatus*, Risso.
Spirontocaris brevirostris, (Dana).	*Spirontocaris pusiola* (K.).
S. lamellicornis (Dana). *S. prionota* (Stimpson).	*S. spinus* (Sowerby).
Pandalus danæ, Stimp.	*Pandalus montagui*, L.
Heteromysis odontops, Walk.	*Heteromysis formosa*, Smi.
Idotea resecata, Stimp.	*Idotea linearis* (Linn.).
Janira occidentalis, Walk.	*Janira maculosa*, Leach.
Leucothoë spinicarpa (Ab.)	*L. spinicarpa* (Ab.).
Paramphithoë pacifica, Walk.	*Paramphithoë assimilis*, S.
Melita dentata (Kröyer).	*M. dentata* (Kr.).
Aoroides columbiæ ♀, Walk.	*Aora gracilis* ♀, Bate. *Microdeutopus anomalus* ♀ (Rathke.).
Podoceropsis excavata (Sp. Bate).	*P. excavata* (Sp. Bate.).
Amphithoë rubella, Dana.	*Amphithoë rubricata* (M.).
Ischyrocerus minutus, Lill.	*I. minutus*, Lill.

Crustacea collected by Dr. W. A. HERDMAN, F.R.S., in Puget Sound, September, 1897 :—

BRACHYOCERA.

Family CANCRIDA.

Genus *Trichocarcinus*, Miers, 1879.

Trichocera, De Haan, Fauna Japon., Crust., p. 16, 1833.
Trichocera, Dana, Crust. U.S. Expedn., p. 299, 1852.

Trichocarcinus oregonensis, (Dana), Pl. XV., fig. 2.

Two adult males and two young; the largest measures 31 mm. long by 42 mm. wide. In the adult the regions are very strongly defined; the teeth on the antero-lateral margin are very granulose, and have lost the alternately spined character described by Dana.

Trichocarcinus recurvidens (Sp. B.). Pl. XV., figs. 1—1*b*.
Platycarcinus recurvidens, Sp. Bate, P.Z.S. 1864. p. 663, Ann. and Mag. Nat. Hist., 3rd Series, vol. XV., p. 488, June, 1865.

Carapace 19 mm. long by 23 mm. wide divided into a number of prominent areolæ of which the surfaces are flattened and granulated; they are separated by deep interspaces. The two gastric lobes are the most prominent, between these is an irregularly shaped small tubercle, and on each side of them a somewhat crescent shaped areola. Behind these are 2 small and a row of 8 moderately large areolæ reaching across the carapace; behind these are a number of small areolæ. The antero- and postero-lateral margins are ill defined; the former has 10 teeth (including the orbital) which are convex on the upper surface, widening distally, and inclined upwards, whence probably the specific name. The frontal margin is 3 mm. wide and 3-lobed, the centre lobe smaller than the

others; a granulated ridge runs backwards from the lateral lobes.

Inner antennæ longitudinal; outer rather long and hairy with the 2 last joints of the peduncle projecting beyond the margin of the carapace, sub-equal in length, the penultimate cordate.

Eye-stalks short with a bifid calcareous appendage on the upper and inner side.

Abdomen 6-jointed, reaching to the base of the outer maxillipedes, very hairy.

Chelipedes robust; carpus and propodos with longitudinal lines of tubercles which increase in size towards the upper margin, the largest being at the base of the moveable finger; merus joint smooth, as long as the carpus.

Ambulatory legs hairy, the propodos shorter than the carpus, dactylus small.

Differs from *T. oregonensis* (Dana) in the flatter, more sharply defined areolæ, in the distal expansion of the teeth of the antero-lateral margin, and in the different form of the calcareous ocular appendage.

Colour of areolæ bright red; chelipedes and legs flesh colour, fingers black. One male.

I have great hesitation in referring Prof. Herdman's single specimen to Sp. Bate's species, as his imperfect description would apply quite as well to *T. oregonensis;* in short I only do so because he calls it a "pretty species," which applies much more to this specimen than to the dull coloured *T. oregonensis*.

The genus *Trichocarcinus* was founded by Miers in place of the pre-occupied genus *Trichocera*, De Haan, in Proc. Zool. Soc., 1879, p. 34, when he called attention to its

affinity with *Cancer*, and again in the Brachyura of the "Challenger" Voyage, p. 210.

It is difficult to see why De Haan, and after him Dana, should have placed it in Corystidæ, the latter author making a family *Trichoceridæ*, consisting of this genus alone. I propose to abolish this family and to place *Trichocarcinus* next to *Cancer*, from which it differs in its more strongly defined regions of the carapace.

Family Corystidæ, Dana.

Genus *Telmessus*, White, 1846.

Telmessus cheiragonus (Tilesius).

Two specimens. Length 22 mm. Width, including lateral spines, 25 mm.*

For description and synonymy see Benedict's excellent Memoir in Proc. U.S. National Museum, vol. XV., p. 223, Pls. XXV. and XXVI. (1892).

CATOMETOPA.

Family Grapsidæ, Dana.

Genus *Heterograpsus*, Lucas, 1849.

Heterograpsus nudus (Dana).

Two specimens. Length 25 mm., width 29 mm.

For synonymy, &c., see Kingsley's Synopsis of the Grapsidæ, Proc. Acad. Nat. Sci., Philadelphia, 1880, p. 208. As, however, Ortmann (Zool. Jahrbuch, Syst. VII., 1894, p. 715) rejects this author's identification of *H. nudus* with *H. sanguineus* (De Haan), I have retained Dana's name.

* In all cases, unless otherwise stated, the largest specimens have been measured. Measurements include rostrum and, except in Brachyura, caudal appendages.

Family INACHIDÆ, Miers.

Genus *Oregonia,* Dana, 1852.

Oregonia gracilis, Dana.

Two males. Length 40 mm. (of which the rostrum is 18 mm.). Width 20 mm.

Genus *Pugettia,* Dana.

Pugettia gracilis, Dana.

Fourteen specimens. Length of largest female 44 mm. Width, including antero-lateral teeth, 30 mm.

Family MAIIDÆ, Miers.

Genus *Scyra,* Dana.

Scyra acutifrons, Dana.

Two males. Length 20 mm. Width 14 mm.

ANOMURA.

Family PAGURIDÆ.

Genus *Eupagurus,* Brandt, 1851.

Eupagurus tenuimanus (Dana).

One large and one small specimen. Length and width of carapace 6 mm. Width of propodos of right chelipede 16 mm.

Eupagurus kennerlyi, Stimpson.

One specimen. Length of carapace 19 mm., width 11 mm. Very near *E. cuanensis* (Thompson), the principal difference being that the dactyli of the ambulatory legs in *E. kennerlyi* are shorter than the propodi, while in *E. cuanensis* they are longer and more curved.

Genus *Paguristes*, Dana.

Paguristes turgidus, Stimpson.

One specimen. This species inhabits a hairy shell, in which its equally hairy chelipedes are difficult to see.

MACRURA.

Family CRANGONIDÆ.

Genus *Crangon*, Fabr., 1798.

Crangon munitus, Dana.

One specimen. Length 45 mm.

Wrongly placed under *Sclerocrangon*, by Ortmann (Proc. Acad. Nat. Sci., Phil., 1895, p. 173). The shape of the rostrum alone shows it not to belong to Sars' genus, as defined in Crust., Norwegian N. Atlantic Expdn., p. 14.

Crangon vulgaris (Linn.), var. *affinis*, De Haan,
= *C. nigricauda*, Stimpson.

Three specimens. Length 42 mm. Width of carapace 7 mm.

I quite admit the differences between *C. nigricauda* and *C. vulgaris* given by Stimpson, but they do not appear to me to be of specific value.

Crangon munitellus, n. sp. Pl. XVI., fig. 1.

Two females with ova. Length 25 mm.

Carapace depressed and sculptured; median carina, with two teeth; *two parallel short carinæ on each side terminating in a tooth;* a curved ridge running from the outer side of the outermost of these teeth to the orbital margin on which is a strong tooth; a strong tooth on the branchial region. Antero-lateral angles acute. Rostrum concave above, rounded at the extremity, as long as the eyes.

Inner antennæ. Peduncles about half the length of the antennal scale.

Outer antennæ. Scale short and broad, with the inner margin thickened, and a strong central rib. Peduncles reaching nearly to the end of the scale, the last joint longer than the others together.

Outer maxillipes reaching beyond the end of the antennal scales.

First pair of feet as long as the second, reaching beyond the end of the antennal scales.

Second and third pair of feet sub-equal. Abdomen tapering abruptly from the 4th segment; 6th segment darker coloured than the others; a dark transverse band on the caudal appendages.

Near *C. munitus,* Dana, but differs in its much smaller size and in the second carina from the median terminating in a tooth half way to the orbital margin, while in *C. munitus* it reaches the margin and has no tooth.

Family HIPPOLYTIDÆ.

Genus *Spirontocaris,** Sp. Bate, 1888.

Spirontocaris grœnlandica (Fabr.).

Hippolyte aculeata (M. Edw.).
H. armata, Owen.
H. cornuta, Owen.

One specimen. Length 35 mm.

I have seen Owen's type specimens from Kamtschatka at the Museum of the Royal College of Surgeons. They are three or four times as large as Dr. Herdman's specimen, but agree in other respects.

Spirontocaris brevirostris (Dana).

Several specimens. Length 50 mm.

* I use this genus in respect to the 7-jointed carpus of the second pair of legs only, without reference to other characters.

Spirontocaris lamellicornis (Dana).

Eight specimens. Length 40 mm.

Very variable in the number and form of the teeth of the rostrum and dorsal carina, but the latter always begins at the hinder margin of the carapace instead of before the middle ("antice ultra medium") as in *Hippolyte ochotensis*, Brandt. From *S. spinus* (Sowerby) it differs in having two post-ocular spines instead of one.

Spirontocaris prionota (Stimpson, Proc. Acad. Nat. Sci., Phil., 1864, p. 153).

Six specimens. Length 35 mm.

Easily distinguished by the serrate margin of the dorsal teeth

Spirontocaris cristata (Stimpson, l. c., 1860, p. 33).

Four specimens. Length 18 mm.

Spirontocaris herdmani, n. sp. Pl. XVI., fig. 2.

One female with ova. Length 30 mm.

Carapace smooth; a strong tooth below the eye and a small one at the lower anterior angle; no post-ocular spine. Dorsal carina beginning rather in front of the middle; rostrum horizontal with sub-parallel margins reaching a little beyond the end of the peduncle of the inner antennæ; upper margin with five teeth, of which two are on the thorax, the 2nd, 3rd, and 4th close together, the distance from the 5th to the point equal to the length from the 2nd to the 4th. Lower margin with one tooth near the point.

Inner antennæ with a spine on each joint of the peduncle.

Outer antennæ. Scale broad at the base, narrowing distally, with a strong spine, half as long again as the sub-equal antennal and antennular peduncles.

Outer maxillipedes reaching considerably beyond the end of the antennal scale.

First pair of legs rather long, reaching beyond the end of the antennal scale; propodos as wide and more than twice as long as the carpus.

Second pair of legs with 7-jointed carpus.

Third pair of legs with three spines on the distal third of the merus joint.

Abdominal segments having the lower margin rounded in the first four, acute in the fifth.

Family PANDALIDÆ.

Genus *Pandalus*, Leach, 1814.

Pandalus danæ, Stimpson (Jour. Boston Soc. Nat. Hist., vol. VI. (1857), p. 62, Pl. XXI., figs. 6 and 7.

Many specimens. Length of largest 80 mm.

SCHIZOPODA.

Family MYSIDÆ.

Genus *Heteromysis*, S. J. Smith, Rep. U.S. Com. of Fisheries, Part I., p. 553, 1874.

Heteromysis odontops, n. sp. Pl. XV., Figs. 3—6.

Four males, four females with ova. Length of latter 11 mm.

Body rather slender.

Rostrum sub-acute, barely half the length of the eyes.

Eyes short and stout, with a prominent distal tooth on the inner margin.

First legs, merus longer than the carpus and propodos united, as 10 : 7, the last small and ill-defined; on the carpus of the right leg 7 spines, viz., a single one and 3 pairs; on the left leg of the same specimen only 3

spines could be seen, but in another specimen there were 7 on both legs.

Second legs, tarsus 4-jointed.

Remaining legs, tarsus 8-jointed.

Telson, lateral margin with about 24 spines extending the whole length, slightly concave, and not incurved near the tip; two terminal spines on each apex, the outer twice as long as the inner; cleft with straight sides armed with about 30 rather long spines.

Uropods, the inner considerably shorter than the outer, with 4 spines at the proximal end of the inner margin.

This species is distinguished from *H. (Chiromysis) microps* (Sars),* *H. formosa*, S. J. Smith,† and *H. norvegica*, Sars‡ (the two last species are united by Norman§), by the teeth on the ocular peduncles, the shorter carpus of the first and the different jointing of the remaining legs, and by the entire lateral margins of the telson being armed with spines instead of the distal portion only. The specific name is from οδος, a tooth, and οψ, an eye.

ISOPODA.

Family Idoteidæ.

Genus *Idotea*, Fabricius, 1798.

Idotea resecata, Stimpson.

Six specimens. Length of largest 55 mm.

Genus *Edotia*, Guérin-Méneville, 1829—44.

Edotia bicuspida (Owen).

One specimen. Length 7 mm.

* Middelhavets Mysider, Arch. f. Math. og. Naturvidenskab, 1877, p. 49, Pls. XIX. and XX.

† Report of U.S. Commissioner of Fisheries, Part I., p. 553 (259), 1874.

‡ Oversigt af Norges Crustacea, Christ. Vidensk. Selsk. Forhandl, 1882, p. 54, Pl. I., figs. 21 and 22.

§ Ann. and Mag. Nat. Hist. Ser. 6, vol. IX., 1892, p. 158, Pl. IX. figs. 6—11.

Family ASELLIDÆ.

Genus *Janira*, Leach, 1814.

Janira occidentalis, n. sp. Pl. XV., figs. 7—10.

Four specimens. Length of female with ova 6·5 mm.

Head rather larger than the first segment, front 3-lobed, the centre lobe sub-acute, rather longer than the others.

Side plates produced into lobes on each side projecting as far as the central lobe and edged with short spines.

First segment with two lateral lobes,* the anterior acute and curved forward.

Second and third segments 4-lobed.*

Fourth segment 3-lobed.*

Fifth and sixth segments 2-lobed,* the anterior much the wider.

Seventh segment with the marginal lobe acute and directed backwards.

Telson wider than long, ovate, the lateral margins simple and produced into an acute posterior tooth; the posterior margin wider than the length of each lateral margin, and having an obtuse central lobe.

The lateral margins of all the segments are sparsely fringed with rather short setæ.

Inner antennæ (antennules) with the first joint large; flagellum reaching a little beyond the middle of the penultimate joint of the peduncle of the outer antennæ.

Outer antennæ as long as the entire animal; a well-developed scale on the 3rd joint; a group of 3 spines on the middle of the inner margin of the penultimate joint, which is about as long as the last peduncular joint.

First pair of legs; propodos rather shorter and much narrower than the carpus; its hind margin finely serrate

* It is difficult to distinguish between the lobes of the actual segment and those of the epimeral plates; I have therefore taken them together.

on the proximal third; carpus swollen, with a few scattered spines on its hind margin.

Remaining parts much as in *J. maculosa*, Leach.

Colour yellowish, freckled with dull red.

AMPHIPODA.

Family LEUCOTHOIDÆ.

Genus *Leucothoë*, Leach, 1814.

Leucothoë spinicarpa (Abildgaard).

One young specimen. Length 3 mm.

I can see no difference between this specimen and those from the British seas, except that the antennæ are relatively shorter and thicker.

Family PARAMPHITHOIDÆ.

Genus *Paramphithoë*, Brugelius, 1859 (part).

Paramphithoë pugettensis (Dana).

Iphimedia pugettensis, Dana.

One specimen. Length 6 mm. Colour orange.

Paramphithoë pacifica, n. sp.

One specimen. Length 4 mm.

Head as long as the first 2 segments.

Eyes oval, dark.

Coxal plates of first two segments about as deep as the segments; no teeth on the lower margin.

Pleon segments without dorsal teeth; posterior angle of the 3rd slightly upturned and sub-acute.

Upper antennæ rather more than half the length of the body; peduncle shorter than the head, the joints progressively decreasing in length and thickness.

Lower antennæ about three-fifths of the length of the upper; the peduncle longer than the head, and reaching

to the end of the 1st joint of the flagellum of the upper antennæ.

Gnathopods feeble, and nearly alike; in the first the front margins of the carpus and propodos are about equally long, in the second the former is rather the shorter; very like the same limbs in *P. assimilis*, G. O. Sars.

Peræopods, the 1st joint of the last 3 pairs wide oval, the hind margins smooth.

Third uropods rather stouter than in *P. assimilis*.

Telson rounded oblong as in *P. assimilis*.

Colour yellowish white.

Very near *P. assimilis*, G. O. Sars, but differs in having no teeth on the lower margins of the first 3 coxal plates, in the smooth margins of the 1st joint of the peræopods, and in the different form of the hind margin of the third pleon segment.

Family GAMMARIDÆ.

Genus *Melita*, Leach, 1814.

Melita dentata (Kröyer).

Seven males, two females. Length of largest male 8 mm.

A widely distributed northern species, ranging from Spitzbergen to Grand Manan on the coast of New Brunswick (lat. 44°-40°). It has been taken by Canon A. M. Norman on the coast of Northumberland, but not, as far as I know, on our west or south coasts, or hitherto on the west coasts of America.

Genus *Mæroides*, n. gen.

Like *Mæra*, Leach, as restricted by G. O. Sars, except—

1. The mandibular palp is very strong, the terminal joint rather shorter than the preceding, but

wider and truncate at the tip, which is setose. This member is very like that of a *Podocerus.*

2. The two pairs of antennæ are of equal length.
3. The last two pair of peræopoda are of equal length.
4. The last pair of uropoda scarcely projects beyond the second pair.

*Mæroides thompsoni,** n. sp. Pl. XVI., figs. 3—6.

Two males. Length 10 mm.

Head, lateral angle acutely lobate.

Body, coxal plates of the three anterior segments about as deep as the body, margins smooth and rounded; third pleon segment with the posterior and lower margins convex, the latter with a single tooth some distance in front of the posterior angle, which is sub-acute; fourth and fifth pleon (1st and 2nd urosome) segments with two teeth on their posterior margins, a seta at the base of each lateral tooth.

Eye large, dark, long-oval, running into the lateral lobe.

Upper antennæ, 1st and 3rd joints of equal length, the 2nd nearly twice as long; the flagellum about as long as the peduncle; accessory appendage 7-jointed.

Lower antennæ as long as the upper, *i.e.*, about half the length of the body, the peduncle and flagellum also being sub-equal; last joint of peduncle the longest.

First gnathopod, 1st joint as long as the carpus and longer than the propodos, which is oval and setose.

Second gnathopod very powerful, the 1st joint longer than the carpus or propodos, the anterior margin of the latter rather longer than the former; the margins of the propodos almost parallel, the anterior slightly concave;

* Named after my friend and fellow-worker in the Crustacea, Mr. Isaac C. Thompson, F.L.S., of Liverpool.

palm almost transverse, concave and defined by an angular prominence, a double tooth in the centre and a larger one at the base of the dactylus, across which it projects a pointed lobe on the outer side. The carpus expands distally till it is as wide as the hand. The posterior margins of both are densely setose.

Peræopods strong, the 4th and 5th of equal length, their first joint broad at the base and narrowing distally, the hind margin slightly serrate.

Uropods all reaching about the same distance behind, the peduncle of the third pair nearly as long as the rami, which are equal and spinous.

Telson reaching to less than half the length of the peduncle of the last uropods, widely but not deeply cleft, a spine and a seta at the end of each division.

Colour yellowish, densely freckled with grey on the back, and with darker spots on the 1st joints of the peræopoda.

The equal upper and lower antennæ, the comparative shortness of the last uropoda, and the length of the wrist in the 2nd gnathopods are obvious distinctive characters of this species.

Family PHOTIDÆ.

Aoroides, n. gen.

Characters (of female) as in *Microdeutopus* and *Aora*, except as follows:—

Mandibular palp very slight and without setæ, except 3 at the tip of the last joint and 1 near the end of the penultimate; these two joints sub-equal, 1st joint very short; cutting edges of mandible 4-toothed.

Upper antennæ without even a rudimentary accessory appendage.

Aoroides columbiæ, n. sp. Pl. XVI., figs. 7—10.

Nine females. Length 5 mm.

Resembles the female of *Microdeutopus anomalus* (Rathke) in all respects except as above and the following:—

Anterior coxal plates with the lower margins rounded.

First joints of the last 3 pairs of peræopods wider than in *M. anomalus*.

First uropods extending a little beyond the second, and these a little beyond the third; peduncle of the third as long as the two equal rami; 2 or 3 spines at its distal end; inner ramus with one spine about the middle of the inner margin; outer ramus with terminal spines only.

It is unfortunate that there was no male among the specimens collected; in this group there is a very close resemblance between the females of the different genera and species, while the males are easily distinguished by their powerful and highly-specialized first gnathopods. The genus, however, is easily distinguished by the entire absence of an accessory appendage to the upper antennæ, and the very slight mandibular palp.

Podoceropsis excavata (Sp. Bate).

One male (both pairs of antennæ wanting). Length 5·5 mm.

As far as can be judged in the absence of the antennæ, there is no difference between this specimen and a young male of about the same size from Liverpool Bay, except a very slight one in the sculpturing of the palm of the second gnathopods.

Family PODOCERIDÆ.

Genus *Amphithoë*, Leach.

Amphithoë rubella, Dana.

One specimen. Length 13 mm.

Upper antennæ as long as the body; lower about half as long.

Genus *Ischyrocerus*, Kröyer, 1838.

Ischyrocerus minutus, Lilljeborg.

Three females with ova. Length 4 mm.

As far as can be judged in the absence of males (always rare in this species) these specimens agree in every respect with those that occur on the British coasts.

Explanation of Plates.

Plate XV.

Fig. 1. Carapace of *Trichocarcinus recurvidens* (Sp. B.).
Fig. 1*a*. Eye of same.
Fig. 1*b*. Under side of front.
Fig. 2. Eye of *T. oregonensis* (Dana).
Figs. 3—6. *Heteromysis odontops*, n. sp.
Fig. 3. Head; fig. 3*a*, base of antennules enlarged.
Fig. 4. First and second legs (*a*—*b*).
Fig. 5. Last leg.
Fig. 6. Telson.
Figs. 7—10. *Janira occidentalis*, n. sp.
Fig. 7. Head and first segment.
Fig. 8. Telson and part of previous segment.
Fig. 9. First leg.
Fig. 10. Third leg.

All drawn with 2 in. objective, except 3*a*, 5, 6, and 10 with 1 in. 1 natural size.

Plate XVI.

Fig. 1. *Crangon munitellus*, n. sp. Twice the natural size.

Fig. 2. *Spirontocaris herdmani*, n. sp. Carapace. Twice the natural size.

Fig. 3. Mandible. *Mæroides thompsoni*, n. gen. & sp.

Fig. 4. Second gnathopod from inside.

Fig. 5. Urosome.

Fig. 6. Third pleon segment.

Figs. 7—10. *Aoroides columbiæ*, n. gen. & sp. ♀.

Fig. 7. Mandible.

Fig. 7*a*. Another mandible (part) showing cutting edges.

Fig. 8. First gnathopod.

Fig. 9. Second gnathopod.

Fig. 10. Telson and third uropod.

Figs. 3, 8, 9, 10 drawn with 1 in., figs. 4, 5, 6 with 2 in., figs. 7*a*, 7, with $\frac{1}{2}$ in. objectives.

[WORK FROM THE PORT ERIN BIOLOGICAL STATION.]

NOTE ON A TETRAMEROUS SPECIMEN OF ECHINUS ESCULENTUS.

By H. C. Chadwick.

Curator of the Biological Station, Port Erin.

With Plate XVII.

[Read May 13th, 1898.]

The subject of this note was dredged by Professor Herdman in Port Erin Bay, during Easter week, 1898, and lay with several other normal specimens in the Laboratory of the Biological Station until the following day, when its abnormal character was fortunately noticed, and it was laid aside for careful examination.

The test measured 5 c.m. in diameter, and was composed of four ambulacra alternating with four interambulacra, one of which was slightly wider than the rest. The apical system (Pl. XVII., fig. 5) consisted of four genital and four ocular plates. One of the latter was much larger than its fellows, and apparently occupied the position of a genital (o', fig. 5) in the system, though it abutted externally upon the summit of one of the ambulacra, and its pore was minute, like those of the other oculars. The normal number of five pairs of peristomial plates with their tube-feet,* and five pairs of tegumentary gills were borne by the peristome (Pl. XVII., fig. 1), and in addition to these, one pair of tube-feet (*tf.'*, fig. 1) which, as will be presently shown, probably

* In "Forms of Animal Life," second edition, p. 560, it is stated that "The feet belonging to the buccal plates of the peristome end not in a disc but in two or more processes." This is not correct if applied to *E. esculentus*, in which the peristomial tube-feet do end in a disc supported by a calcareous rosette similar to those of the ordinary tube-feet of the test.

represented those of the absent ambulacrum. Each of these tube-feet was seated upon a minute ossicle (*os.*, fig. 3), through the centre of which ran a perforation. Upon the distal margin of the ossicle, and encircling the tube-foot, spines and pedicellaria were seated (*sp*, *ped.*, fig. 2). In the semi-contracted condition in which it was examined the ossicle and its tube-foot together measured 3 mm. in length.

The test being opened by a meridional incision, the intestine was found to follow the normal course, and four well-developed ovaries occupied the interambulacral areas. The jaw apparatus, or "Aristotle's lantern," was quite normal, all its parts numbering five. But, there being only four ambulacra, two of the five pairs of adductor muscles of the teeth were attached to the margin of one interambulacrum (*amt.*, fig. 4), and, between the two pairs, a feebly developed pair of opening muscles of the teeth were also attached. Each ambulacrum bore a well-developed auricula. The circum-oral water vessel bore five Polian vesicles, and five radial vessels proceeded from it. Of these latter four traversed the corresponding ambulacra to the apex of the test in the normal way, while the fifth passed through the peristome near its margin, and ended in the pair of tube-feet described above. This anatomical relationship points to the view suggested above, *i.e.*, that the tube-feet represented those of the absent ambulacrum, upon which it follows that the perforated ossicles upon which they were seated were the feeble and displaced representatives of the plates of that ambulacrum.

Assuming that the madreporite occupied its normal position on the right anterior genital plate (genital 2 according to Lovèn's formula), it is evident that the genital marked * in fig. 5, occupied the position of the

normal genitals 1 and 5, ocular I. being entirely absent. The absent ambulacrum is therefore I., the left one of the three which normally form the trivium.

Explanation of Plate XVII.

Fig. 1. Diagrammatic figure of the peristome and ambulacra, showing the exact positions of the tegumentary gills, peristomial tube-feet and the pair of tube-feet representing those of the absent ambulacrum.

Fig. 2. One of the pair of tube-feet marked *tf′* in fig. 1, magnified.

Fig. 3. The ossicle *os* in fig. 2, viewed from above to show the perforation through which the radial water vessel opened into the tube-foot.

Fig. 4. The "Lantern of Aristotle," viewed from the side, to show the abnormal arrangement of the two pairs of adductor muscles of the teeth.

Fig. 5. Diagrammatic figure of the apical system of plates × 3. The ocular plates are indicated by Roman numerals, the genital plates by Arabic numerals. The dotted outline indicates the position in the system of the absent ocular plate.

List of Reference Letters.

am., ambulacra; *amt.*, adductor muscles of the teeth; *au.*, auricula; *m.*, mouth; *mad.*, madreporite; *ped.*, pedicellaria; *ptf.*, peristomial tube-feet; *sp.*, spines; *t.*, test; *tf′.*, abnormal tube-feet.

REPORT on a small COLLECTION of ANTARCTIC PLANKTON from the NEIGHBOURHOOD of the SOUTH SHETLAND ISLANDS, collected by the STAFF of a DUNDEE WHALER in 1892-3.

By Isaac C. Thompson, F.L.S.;

With NOTES on the DIATOMACEÆ,

By Thomas Comber, F.L.S.

With Plates XVIII. and XIX.

[Read May 13th, 1898.]

The material forming this collection was recently placed in my hands for examination by Professor D'Arcy W. Thompson, C.B., by whose orders it was collected. It was contained in eighteen small vials, and since supplemented by about thirty larger bottles, the latter being mostly similar in date to the former, and simply labelled "Antarctic," with the date of collection and in most cases the surname of the collector.

Indeed, I have been able to obtain only the most meagre particulars as to collection, no depths or localities being mentioned. The dates given are from February 26th, 1892, to December 12th, 1893, and presumably the material was all collected at the surface by tow-net. The collection is composed of Copepoda, represented by seven species, a few Schizopods and other Crustacea, a considerable number of Sagitta, a few worms, a few Peridineæ, Foraminifera represented by *Globigerina,* and masses of floating Diatomaceæ representing several species. The latter appeared to me of such interest that I handed them over to my friend, Mr. Thomas Comber, F.L.S., whose

report upon them, with a drawing and description of a new species, are included herewith.

The general character of the plankton obtained bears out to a considerable extent Dr. John Murray's remarks upon the pelagic life of the Antarctic Ocean.

In a paper recently read before the Royal Society upon "The Scientific Advantages of an Antarctic Expedition," he says:—

"In the surface waters of the Antarctic there is a great abundance of diatoms and other marine algæ. These floating banks or meadows form primarily not only the food of pelagic animals, but also the food of the abundant deep-sea life which covers the floor of the ocean in these south polar regions. Pelagic animals, such as Copepods, Amphipods, Molluscs, and other marine organisms, are also very abundant, although species are fewer than in tropical waters. Some of these animals seem to be nearly, if not quite, identical with those found in high northern latitudes, and they have not been met with in the intervening tropical zones. The numerous species of shelled Pteropods, Foraminifera, Coccoliths and Rhabdoliths, which exist in the tropical surface waters, gradually disappear as we approach the Antarctic circle, where the shelled Pteropods are represented by a small *Limacina*, and the Foraminifera by only two species of *Globigerina*, which are apparently identical with those in the Arctic Ocean. A peculiarity of the tow-net gatherings made by the "Challenger" Expedition in high southern latitudes, is the great rarity or absence of the pelagic larvæ of benthonic organisms, and in this respect they agree with similar collections from the cold waters of the Arctic seas. The absence of these larvæ from polar waters may be accounted for by the mode of development of benthonic organisms. It must be remembered that

many of these pelagic organisms pass most of their lives in water of a temperature below 32° F., and it would be most interesting to learn more about their reproduction and general life-history.

"In the Southern and Sub-antarctic Ocean a large population of the Echinoderms develop their young after a fashion which precludes the possibility of a pelagic larval stage. The young are reared within or upon the body of the parent, and have a kind of commensal connection with her till they are large enough to take care of themselves. A similar method of direct development has been observed in eight or nine species of Echinoderms from the cold waters of the northern hemisphere. On the other hand, in temperate and tropical regions the development of a free-swimming larva is so entirely the rule that it is usually described as the normal habit of the Echinodermata. This similarity in the mode of development between Arctic and Antarctic Echinoderms (and the contrast to what takes place in the tropics) holds good also in other classes of Invertebrates, and probably accounts for the absence of free-swimming larvæ of benthonic animals in the surface gatherings in Arctic and Antarctic waters."

Of the Copepoda obtained, curiously enough the commonest species is apparently new to science. It agrees generally with Scott's genus *Paracartia*, in which I have placed it as *Paracartia antarctica*, n. sp. It occurred in eighteen of the gatherings.

The well-known *Calanus finmarchicus*, so commonly distributed throughout our northern latitudes, appears to be equally common about the Antarctic, and occurred in sixteen of the gatherings.

Associated with *C. finmarchicus*, and fairly plentiful in some of the bottles, was the large red Arctic species

C. hyperboreus, formerly passed over as a mere Arctic vatiety of *C. finmarchicus*, but now separated by Giesbrecht as a distinct species. Besides being of a uniformly larger size than *C. finmarchicus*, it differs from the latter in having lateral nipple-shaped projections at the terminations to the cephalothorax, in the large square-shaped first joint of the abdomen, and in the form of the basal serratures of the fifth pair of feet.

From the peculiar brittleness of the anterior antennæ and the swimming feet, it is a rare thing to find anything approaching a complete specimen of this species.

While expressing in a previous paragraph the general extent to which this collection bears out Dr. Murray's remarks on Antarctic fauna, a considerable exception must be taken to his remark—"Some of these animals seem to be nearly, if not quite, identical with those found in high northern latitudes, and they have not been met with in the intervening tropical zones." As regards the species last alluded to—*Calanus hyperboreus*—the statement is strictly applicable, this species not having been found, so far as I am aware, between the North and South Shetland Islands, represented by 60° N. lat. and 60° S. lat. But *Calanus finmarchicus* has been reported from Australia, 37° S. lat., and I found it at the Canary Islands, 30° N. lat. So there is hardly good reason to suppose that it could not survive an extreme tropical heat, and it might easily migrate across or be carried by a vessel.

Pseudocalanus elongatus, also well-known as a northern form, was common throughout the gatherings. It has, however, even less claim than *Calanus finmarchicus* to be classed as exclusively bipolar, as I recently found it in some plankton sent to me by Staff-Surgeon P. W. Bassett Smith, collected in the Indian Ocean. *Metridia longa*

occurred in only one haul. It also is a common northern form, and I recently found it plentiful in material collected by Dr. G. H. Fowler, in H.M.S. "Research," off the Faroe Islands. It occurs about our British and French shores in fair numbers.

The two remaining species, *Oithona spinifrons* and *Ectinosoma atlanticum*, have a wide distribution, especially in northern latitudes. Both were sparingly distributed in this collection.

Paracartia antarctica, n. sp. Pl. XVIII., figs. 1—12.

Length (exclusive of tail setæ) 1·75 mm. Male rather smaller and more slender than the female. The female is conspicuous by the acute lateral angles of the last thoracic segment of the cephalothorax. Anterior antennæ rather shorter than the cephalothorax, 20-jointed in the female (fig. 3) and 11 in the right male antenna (fig. 2). The ninth joint in the latter is finely serrated on the under surface, a geniculation occurring between the 9th and 10th joints.

Posterior antennæ and mouth organs similar to those of *P. spinicaudata*, Scott. Outer branch of four first pair of swimming feet 3-jointed, the division between the two terminal joints in first pair (fig. 9) being almost imperceptible. Inner branch 2-jointed. Fifth pair of feet in female (fig. 12) 1-branched, each branch 2-jointed. Basal joint somewhat quadrangular, and terminating on the posteroir inner side, with a strong lanceolate spine. Terminal joint bifurcates at apex forming two spines, with a small seta on inner side of outer one.

The fifth pair in the male (fig. 11) is large and conspicuous, forming a strong clasping organ. The right foot has two broad basal joints, terminating in a long sickle-shaped,

spinous joint, with a small one at apex. The left foot is composed of three stout joints and a strong apical tooth, with a short seta near apex.

Abdomen 5-jointed in the male, three in the female. Length of caudal stylets about twice the width, each bearing one lateral seta and four terminal setæ, all plumose. Both males and females were found plentifully in many of the tow-nettings, the females being much the most abundant.

It is necessary here to state that two bottles of material are, after consideration, not dealt with in this report for the following reasons:—

The first, duly labelled "Antarctic," with a date corresponding with the rest, was found to contain several specimens of the common "fresh-water flea," *Daphnia pulex*, and of the fresh-water Copepoda *Diaptomus* and *Cyclops*, but no marine forms! It is, of course, quite possible that they may have been found in a ship's tank, and put into the vial and labelled carelessly, or by some-one trying to be funny, or they may have been found during a land excursion, in some inland tarn.

The second bottle is uniform with the others, but labelled simply "Tow-net, 16/4/93." It contains a large number of tropical species of Copepoda, including *Calanus vulgaris*, *Pontellæ*, *Monops*, *Euchætæ*, *Corycæus*, *Copilia*, *Miraceæ*, *Oncæa*, &c., so entirely differing from those found in cold Antarctic waters that in the absence of any more reliable information than the label gives, or I have been able to elicit, it would be unwise to include them as Antarctic species.

In concluding this fragmentary report, I should like to join in the hearty expression of the advantages to science to be derived from a well-equipped expedition to the

Antarctic, as recently advocated by Dr. John Murray, F.R.S. For, as he well puts it:—

"Every department of natural knowledge would be enriched by systematic observations as to the order in which phenomena coexist and follow each other, in regions of the earth's surface about which we know very little or are wholly ignorant. It is one of the great objects of science to collect observations of the kind here indicated, and it may be safely said that without them we can never arrive at a right understanding of the phenomena by which we are surrounded, even in the habitable parts of the globe."

NOTES on the DIATOMACEÆ COLLECTED.

By Thomas Comber, F.L.S.

The following is a list of Diatomaceæ which I observed in the material from South Shetland Islands, Antarctic, sent by Mr. I. C. Thompson:—

Thalassiosira antarctica, n. sp., frequent.
Nitzschia seriata, Cleve, rare.
Rhizosolenia sima, Cstr., rare.
R. setigera, Brtw., frequent.
R. inermis, Cstr., rare.
Chætoceros boreale, Bailey, occasional.
C. incurvum, rare.
Corethron criophilum, Cstr., rare.
C. cometa, Brun., one specimen observed.
C. unguiculatum, n. sp.
Hemiaulus balaustium (= *Eucampia*, Cstr.)
Biddulphia membranacea, Cleve, new variety.
Biddulphia, n. sp.
Fragilaria linearis, Cstr., rare.
Asterionella glacialis, Cstr.

Count Castracane, in his report on the Diatoms collected by H.M.S. "Challenger," established (p. 813) a new genus, CORETHRON, for certain forms collected in the Antarctic Ocean. They are allied to *Bacteriastrum*, and the author characterises his genus as having frustules cylindrical, free (?); valves convex, surrounded by a corona of radiating awns.

He divides it into two sections, one with smooth, the other with echinated awns. A form which occurs rather sparingly in Mr. Thompson's gathering seems to be intermediate between the two; for the awns of one valve are flat, and their margin distinctly dentate; the awns of the other valve appear smooth. But the main feature of the form is the presence of peculiar appendages round the upper valve, intermingled with the awns. They are flexuose, flattened and expanded at base and apex, the latter bearing a double claw, set at right angles to its pedicel. The specific name has reference to these.

Corethron unguiculatum, n. sp. Pl. XIX.

Frustule lenticular to spherical; valve varying from convex to hemispherical, smooth; awns erect, spreading, or recurved. Those of one valve flattened, dentate, and intermingled with flexuose clawed appendages; those of the other valve smooth.

Antarctic plankton, near South Shetland Islands.

For list of Diatoms observed at the surface, station 157, in the Antarctic, see—

Report on the Scientific results of the Voyage of H.M.S. "Challenger." (Summary of Results.) Part I. (published 1895), p. 517.

Besides verifying (and correcting) the list originally compiled by Rattray, about 30 species, I was able to add thereto about 18 species.

Explanation of Plates.

Plate XVIII.

Paracartia antarctica, n. sp.

Fig. 1.	Male, lateral view	1 in.	Ross. obj.
Fig. 2.	,, right anterior antenna	$\frac{1}{4}$,,	Gundlach ,,
Fig. 3.	Female ,, ,,	$\frac{1}{4}$,,	,, ,,
Fig. 4.	Posterior antenna	$\frac{1}{4}$,,	,, ,,
Fig. 5.	Mandible and palp	$\frac{1}{4}$,,	,, ,,
Fig. 6.	Maxilla	$\frac{1}{4}$,,	,, ,,
Fig. 7.	Anterior footjaw	$\frac{1}{4}$,,	,, ,,
Fig. 8.	Posterior ,, ...	$\frac{1}{4}$,,	,, ,,
Fig. 9.	Foot of first pair	$\frac{1}{4}$,,	,, ,,
Fig. 10.	,, fourth pair... ...	$\frac{1}{4}$,,	,, ,,
Fig. 11.	Fifth pair of feet, male ...	$\frac{1}{4}$,,	,, ,,
Fig. 12.	Fifth pair of feet, female ...	$\frac{1}{4}$,,	,, ,,

Plate XIX.

Corethron unguiculatum, n. sp.

× 1,500.

ACTINOLOGICAL STUDIES.

I.—The MESENTERIES and ŒSOPHAGEAL GROOVES of ACTINIA EQUINA, Linn.

By Joseph A. Clubb, M.Sc. (Vict.),
Victoria University Scholar in Zoology;
Assistant Curator of the Derby Museum, Liverpool.

With Plate XX.

[Read May 13th, 1898.]

Up to comparatively recently external characters alone served as a means of identification and as a basis for the classification of the Anemones, and thanks to the work of Prof. E. Forbes, P. H. Gosse and others, we have excellent accounts of the external appearance and habits of our British Actinians. But latterly, the attention of investigators has been directed more and more to the details of the internal anatomy, as forming a sounder and more scientific method of arriving at a true understanding of the natural relations of this group of animals. The brothers Hertwig, by the publication of their paper on the Anatomy of Actinians (1879), have done much to bring this about, and later, Dr. Richard Hertwig, in his Report on the "Challenger" Actinians (1882), laid down lines of classification based entirely on anatomical characteristics. In 1889 Prof. Haddon published Part I. of a "Revision of the British Actiniæ," in the introduction to which he makes the statement that "apart from external characters, we are unable to assign to most of them (the British species) a position in the groups proposed by Prof. R. Hertwig, on account of the absence of

any knowledge of their anatomy." The great importance and necessity of a work of this character is then apparent, and it is the unfeigned regret of all workers in this group of animals that Prof. Haddon has not completed this revision.

The principal morphological characters of the Hexactiniæ are the hexamerous arrangement of the mesenteries in pairs and the presence of two "œsophageal grooves"—the "siphonoglyphs" of some authors—associated with two pairs of "directive" mesenteries. But a large amount of variation from this typical condition has been shown to exist in a number of species, both in the arrangement of the mesenteries and in the number of œsophageal grooves and directive mesenteries. It is, therefore, of the greatest importance that not only should there be a thorough knowledge gained of the anatomy of these animals, but that that knowledge should be founded on the examination, where possible, of a large number of specimens, so as to prevent the possibility of mistaking individual variations for characteristics of the species. It is only by this means, in view of the amount of variation shown to exist, that a true and faithful estimate can be formed of the morphological and phylogenetic value of the various anatomical characters.

Acting on the kind suggestion of Prof. Herdman, to whom I wish to record my sincere thanks for much valuable advice and active interest in the work, I have commenced a series of observations on the various species of Actinians found in this neighbourhood. It is my intention to take them in rotation, and examine a large number of specimens of each species, in order to determine the constancy or otherwise of the different points of their anatomy. This, my first contribution, deals with the well-known species, *Actinia equina*, Linn.—the

A. mesembryanthemum of Gosse, popularly known as the Beadlet, and a very common form around our shores. The specimens examined were all collected in the neighbourhood of Port St. Mary, Isle of Man—the major portion by myself during a short holiday spent there in June of last year, and a second consignment was obtained later from the Port Erin Biological Station, collected by the Curator, Mr. H. C. Chadwick. This species varies greatly in its external colouration, and, although most of my specimens were of the bright-red or crimson variety, I obtained a good many of the various shades of green and liver-brown.

The killing, fixing and preserving of Anemones is by no means easy to do satisfactorily, for it is of great importance in view of future work, especially of an anatomical character, that not only should they be thoroughly hardened and preserved, but also, that they should be fixed in an expanded condition. The method adopted in the present case, with a fair amount of success, was as follows:—The animals were allowed to expand in shallow dishes of fresh sea-water, when magnesic sulphate was cautiously added in sufficiently large quantity, so as to make a fairly strong solution. This is the stupefying method recommended by Tullberg (1891). On the expiration of several hours, the tentacles become totally irresponsive to stimuli, and then, and not till then, concentrated formalin was added to the sea-water in sufficient quantity to make about a two per cent solution. This fixes the tissues, and the Anemones were then arranged in a single layer, and a second solution of formalin of 10 per cent strength poured over them. It is of the greatest importance in preserving Anemones that the preserving fluid should have free access to every part, and for purposes of histological research it is advisable

to syringe the internal cavity through the mouth opening. Otherwise, and if packed too soon into bottles, where they lie one on top of another, a certain amount of maceration takes place, and disappointment is the result.

The specimens were obtained as large as possible, and usually possessed five or six circles of tentacles, arranged in the usual manner. The "marginal spherules," or "bourses chromatophores," were of the usual azure blue colour, which varied considerably, however, in intensity. They also varied much in number and size. The following is a brief record of the essential features of the internal anatomy of *A. equina*, in its normal condition:— The œsophagus is usually much corrugated on its inner surface, and produced at its lower end into two processes, the œsophageal lappets. In the living condition the two œsophageal grooves can be easily distinguished by the colour, being of a greenish cast, quite different from the other parts of the wall of the œsophagus. This distinction was observable in the specimens preserved in formalin, when I afterwards commenced work on them a month or so later. But I was compelled to transfer all my preserved material into spirit, owing to the extremely irritating action of the fumes of the formalin on the mucous membrane of the nose and throat, and the painful effect on the eyes. The spirit effectually destroyed this colour distinction, and it became necessary to examine with greater care in order to determine the œsophageal grooves. For, although in most cases they were distinguishable by their greater depth, in many instances this was not so, and it was only by careful examination of the surface epithelium, confirmed by a transverse section, that their existence could be with certainty demonstrated. Oftentimes, from a cursory examination only of the œsophagus, I formed erroneous conclusions,—

in some cases the siphonoglyphs were so indistinct as not to be distinguishable from the ordinary longitudinal grooves of the œsophagus, and in other cases some of the ordinary longitudinal grooves were so enlarged and exaggerated as to lead me to think they were true siphonoglyphs.

The mesenteries are attached lengthwise to the sides of the column, the "complete" mesenteries stretching across and uniting with the œsophagus, the "incomplete" mesenteries falling short and hanging freely in the cavity. Most of my specimens exhibited twelve pairs of complete mesenteries representing the first and second cycles. There were usually three other cycles of "incomplete" mesenteries present. This arrangement is represented by the diagrammatic fig. 1, Pl. XX. Of the complete mesenteries, two kinds are distinguished by the arrangement of the mesenterial muscles. Each mesentery has longitudinal muscle fibres on the one face, and transverse muscle fibres on the other, forming in each case a slightly raised layer. Each pair of mesenteries has similar muscles on the sides facing each other, that is, projecting into the endocoele or space enclosed between each pair of mesenteries. In all cases except two, it is the longitudinal muscle series which are so arranged, and these two exceptions, which are known as the "directive" mesenteries (Pl. XX., fig. 1, *d.*), have the transverse muscles facing the endocoele or intra-mesenteric space, and the longitudinal muscles facing the exocoele or inter-mesenteric space. The remaining complete mesenteries are known as the "non-directives" (Pl. XX., fig. 1, *n. d.*).

I have examined 165 specimens of *Actinia equina*, and out of these, 158 had the arrangement of mesenteries, the number of œsophageal grooves and directive mesenteries

in accordance with the details sketched above; seven, or 4·24 per cent only showing variation from this typical condition. Many of the specimens were sufficiently large to dissect with knife and scissors, by the aid of a simple dissecting microscope; the others were cut transversely with a common razor and the details of the arrangement of œsophageal grooves and mesenteries made out from transverse sections.

In discussing the variation in anatomical characteristics which I have found in *Actinia equina*, I will briefly refer, for purposes of comparison, to the observations made by other investigators on variations in other species.

The Hexamerous arrangement of Mesenteries.—A number of species have been described in specimens of which heptamerism, octamerism, or decamerism has obtained, instead of the normal hexamerism, or arrangement of mesenteries in six or multiples of six.

Last year Prof. McMurrich (1897) described seven specimens of *Sagartia spongicola*, in which in two the mesenteries were arranged on a heptamerous plan, and in three were arranged on an octamerous plan. In the whole of the 165 specimens of *Actinia equina* examined by me, there was not one which departed from the hexamerous arrangement. This question is usually decided on the evidence of the "complete" mesenteries only. All of these are of the "incomplete" series at first, and it is merely a question of age as to when they become of the "complete" series. In several of the specimens of *Actinia equina*, I found some of the mesenteries of the same circle complete and some incomplete, sometimes even the same pair has had one mesentery complete and the other incomplete. Again, the attachment of the mesenteries to the œsophagus gradually extends downwards from above, and if the arrangement

is being determined by transverse section only, and the section not being quite horizontal passes lower on the one side than on the other, it may show the mesenteries of the same circle incomplete on the one side and complete on the other. It is of the greatest possible importance to bear these points in mind, in deciding the question as to whether the hexamerous arrangement is retained or not, and special care should be taken to distinguish the primary and secondary circles of mesenteries from each other.

Œsophageal Grooves or Siphonoglyphs.—The instances of variation found by me in *Actinia equina* are all in the number and position of the œsophageal grooves, and it is in these particulars that other investigators have found most variation in other species. Out of 131 specimens of *Metridium marginatum*, a common American species, Parker (1897) records that 59 per cent had only one siphonoglyph, a single specimen had three and the remaining 41 per cent *only* had two. G. Y. Dixon (1888, p. 120) observed that in *Sagartia venusta*, *S. nivea*, and *S. miniata*, one or two siphonoglyphs may occur; the brothers Dixon (1891, p. 19), confirmed by the observations of several others, show the presence of either one or two in *Metridium dianthus*; while Haddon and Shackleton (1893) record that from two to seven occur in different specimens of *Condylactis ramsayi*.

In the case of *Sagartia spongicola*, previously referred to, McMurrich (1897) records variations in this respect in all the seven specimens examined. He speaks of the "directive" mesenteries only, but in the absence of any statement to the contrary, it may be concluded that each pair of directives had an "œsophageal groove" associated with it. He describes one with two pairs of directives, but not arranged opposite each other, five with

three pairs and one with four pairs. Hence it is seen that in many species uniformity in the number of œsophageal grooves is by no means characteristic.

As before mentioned, in *Actinia equina* all the seven variations which occurred among the 165 specimens examined were in the arrangement and number of the œsophageal grooves. In four specimens a single œsophageal groove only existed, in one specimen three existed, and in two specimens two œsophageal grooves were present, but were not arranged opposite each other as in the normal condition. It will be noticed that a decrease in the number is more common than an increase, and this is in accordance with the records of other investigators, and to which McMurrich draws attention in his paper on *Sagartia spongicola* (1897, p. 116).

Of the four specimens with the single œsophageal groove, two had two cycles of mesenteries complete (1 pair of directives, 11 pairs of non-directives); one had the primaries alone complete (1 pair directives, 5 pairs non-directives); and the remaining one had the primaries and four of the secondaries complete (1 pair directives, 9 pairs non-directives), the two remaining pairs of mesenteries of the second cycle being incomplete. This last condition is shown diagrammatically in Pl. XX., fig. 2. (In the diagrammatic figs. 2, 3, 4, and 5, the primary and secondary mesenteries only are shown).

The specimens possessing three œsophageal grooves exhibited perfect hexamerism like all the others, and possessed twelve complete mesenteries (3 pairs directives (*d.*), 9 pairs non-directives (*n. d.*), see Pl. XX., fig. 3). Of the three œsophageal grooves (*œ. g.*), two occupied the normal position opposite each other.

The third type of variation, found in the two specimens in which the two œsophageal grooves present were not

arranged opposite each other, is shown in Pl. XX., figs. 4 and 5. The one differs from the other in the relative position of the œsophageal grooves (*œ. g.*). In one (fig. 4) they are close together and are associated with adjacent pairs of mesenteries of the first order; and in the other (fig. 5) they are separated from each other by three pairs of complete mesenteries of the first order on the one side, and by one pair on the other. In both cases the first cycle of mesenteries only is complete.

Directive Mesenteries.—In every instance of the 165, I found each œsophageal groove in relation with a pair of directive mesenteries, and I never found directive mesenteries otherwise than in relation with œsophageal grooves. Of the 131 specimens of *Metridium marginatum* examined by Parker (1897), he records that in every case, whether possessing one, two or three œsophageal grooves, there was always associated with each a pair of directive mesenteries. This exact correlation of the two structures is, however, not the case in all Actinians. McMurrich (1891) and others have shown that in certain forms *(Peachia, Oractis, Ptychodactis)* directive mesenteries occur, and no œsophageal grooves are discernable. But this want of correlation between the two sets of structures is very exceptional, and the great majority of the species investigated show the same exact correlation as is seen in *Metridium marginatum* and *Actinia equina*.

My observations on the whole tend to show that *Actinia equina* has a constancy of character not possessed by many other Actinians, and it is of importance to find a dominant species, as *A. equina* undoubtedly is, so free from variation as this record shows. That certain species are not so liable to variation as others, and are much more constant in their essential characters, has been shown by other investigators to be the case. Even species of the

same genus show marked differences in this respect. The brothers Dixon record that in four specimens of *Bunodes thallia* (1889, p. 318), one, two, three, and four œsophageal grooves were found; while in *Bunodes verrucosa*, on the other hand, the whole of twenty-three specimens examined had the normal number. I consider, then, that the constant hexamerism which I find obtains without exception in the specimens of *Actinia equina* examined by me, even where variation in other directions has crept in, is an interesting feature of the species.

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Exlanation on Plate XX.

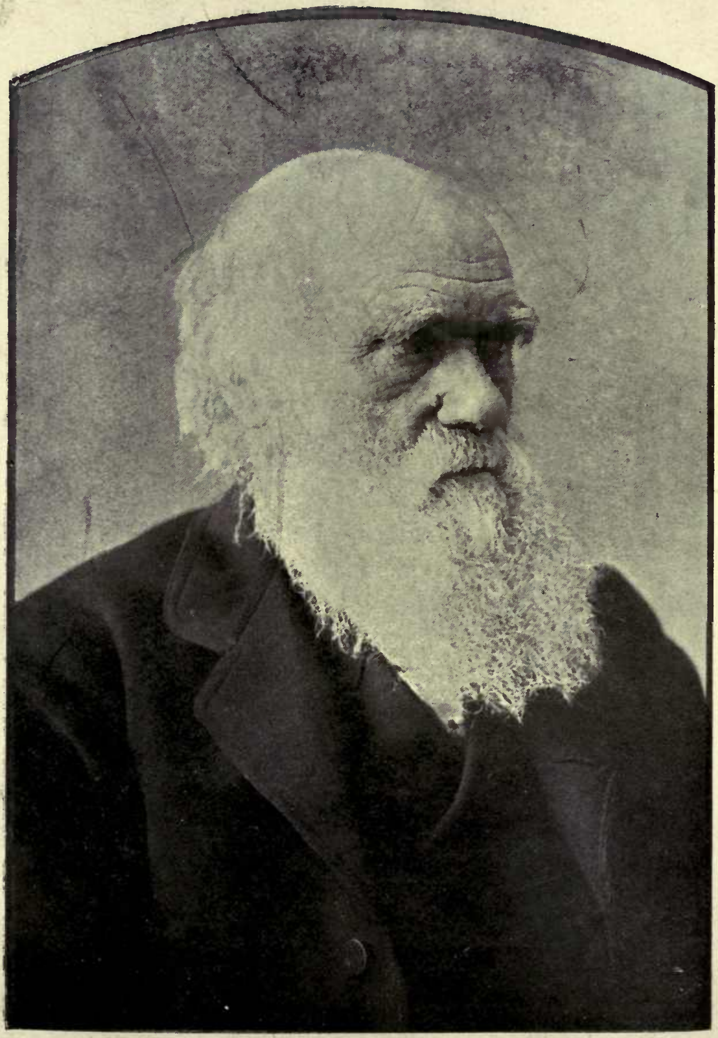
Reference Letters :— *d.*, directive mesenteries; *n.d.*^{i}, non-directive mesenteries of the first cycle; *n.d.*^{ii}, non-directive mesenteries of the second cycle; i^{ii}, i^{iii}, i^{iv} and i^{v}, incomplete mesenteries of the second, third, fourth and fifth cycle respectively; *œ.*, œsophagus; *œ. g.*, œsophageal grooves.

Fig. 1. Diagrammatic T. S. showing the arrangement of mesenteries in the typical specimen. The first cycle of mesenteries is shown complete, and the arrangement of the remaining mesenteries is represented in one-sixth part only.

Fig. 2. Diagrammatic T. S. illustrating the condition found in the specimen with a single œsophageal groove, and four pairs of mesenteries of the second cycle complete, and two incomplete.

Fig. 3. Diagrammatic T. S. illustrating the arrangement of mesenteries in the specimen with three œsophageal grooves.

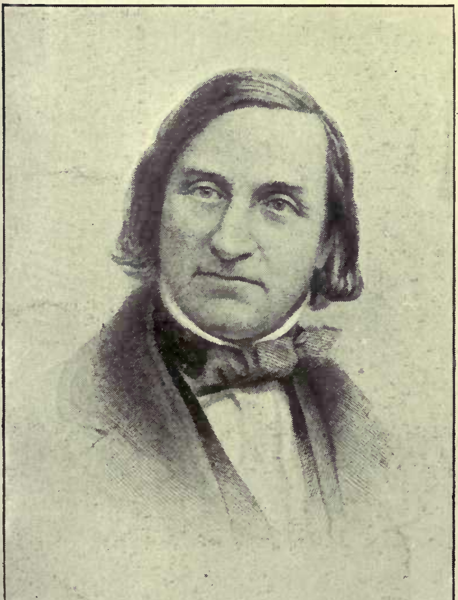
Figs. 4 and 5. Diagrammatic T. Ss. showing the arrangement in the two specimens where the relative situations of the œsophageal grooves were abnormal.



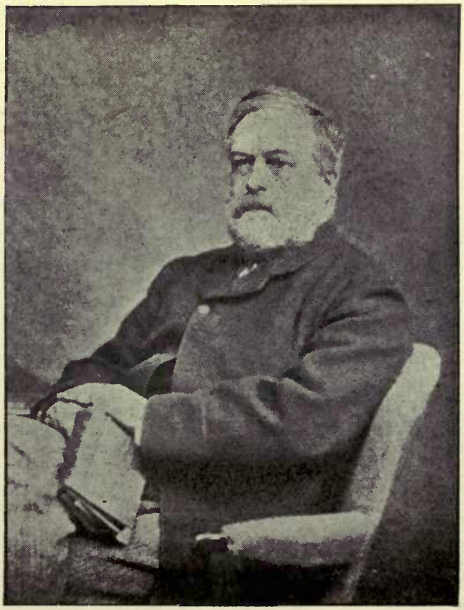
DARWIN.

CUVIER.

ERASMUS DARWIN.



EDWARD FORBES.



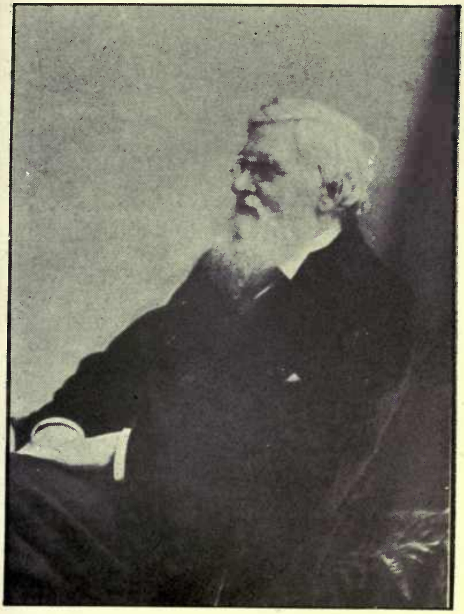
WYVILLE THOMPSON.

HUXLEY.

PASTEUR.

HERBERT SPENCER.

HAECKEL.

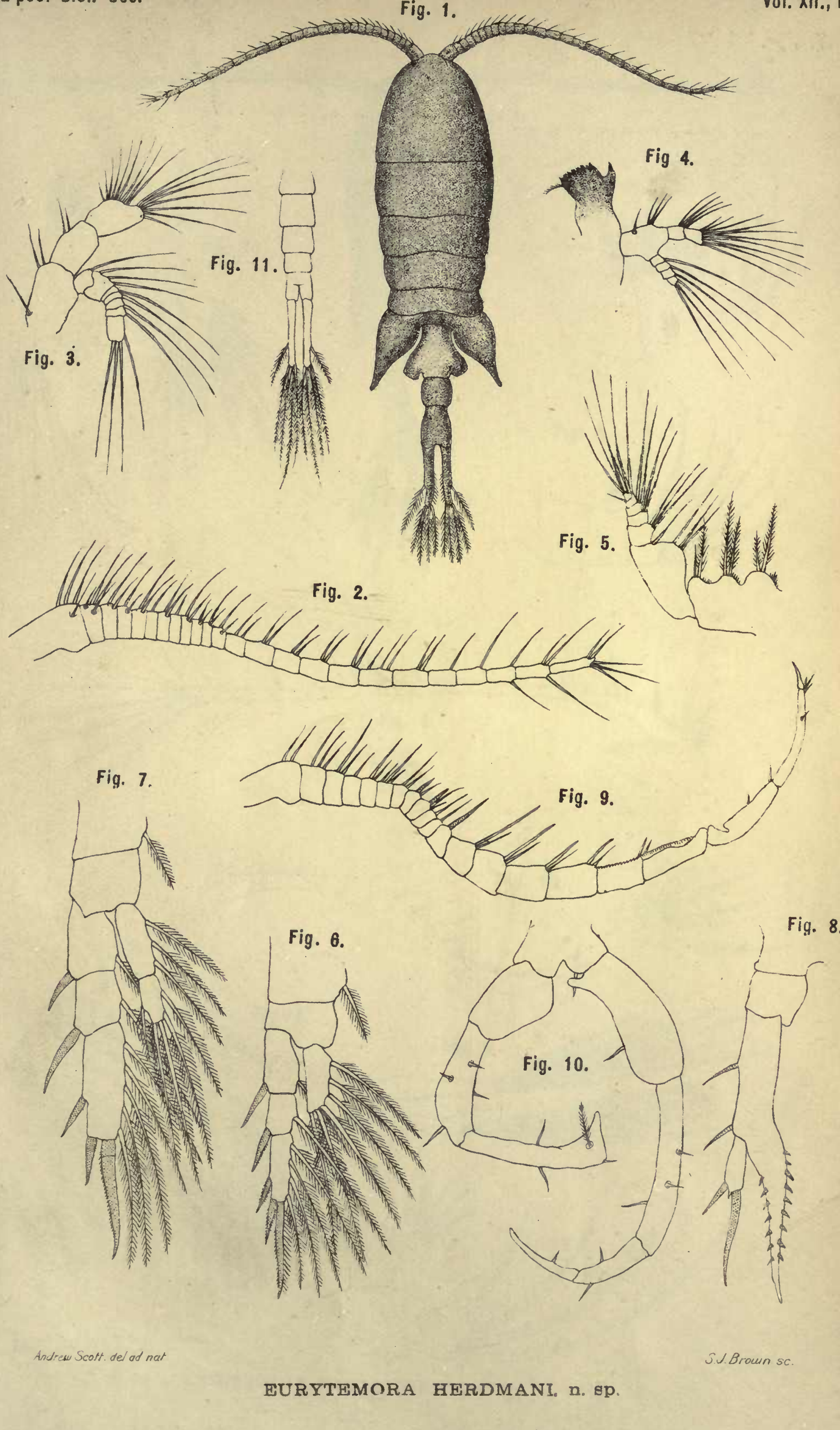


WALLACE.

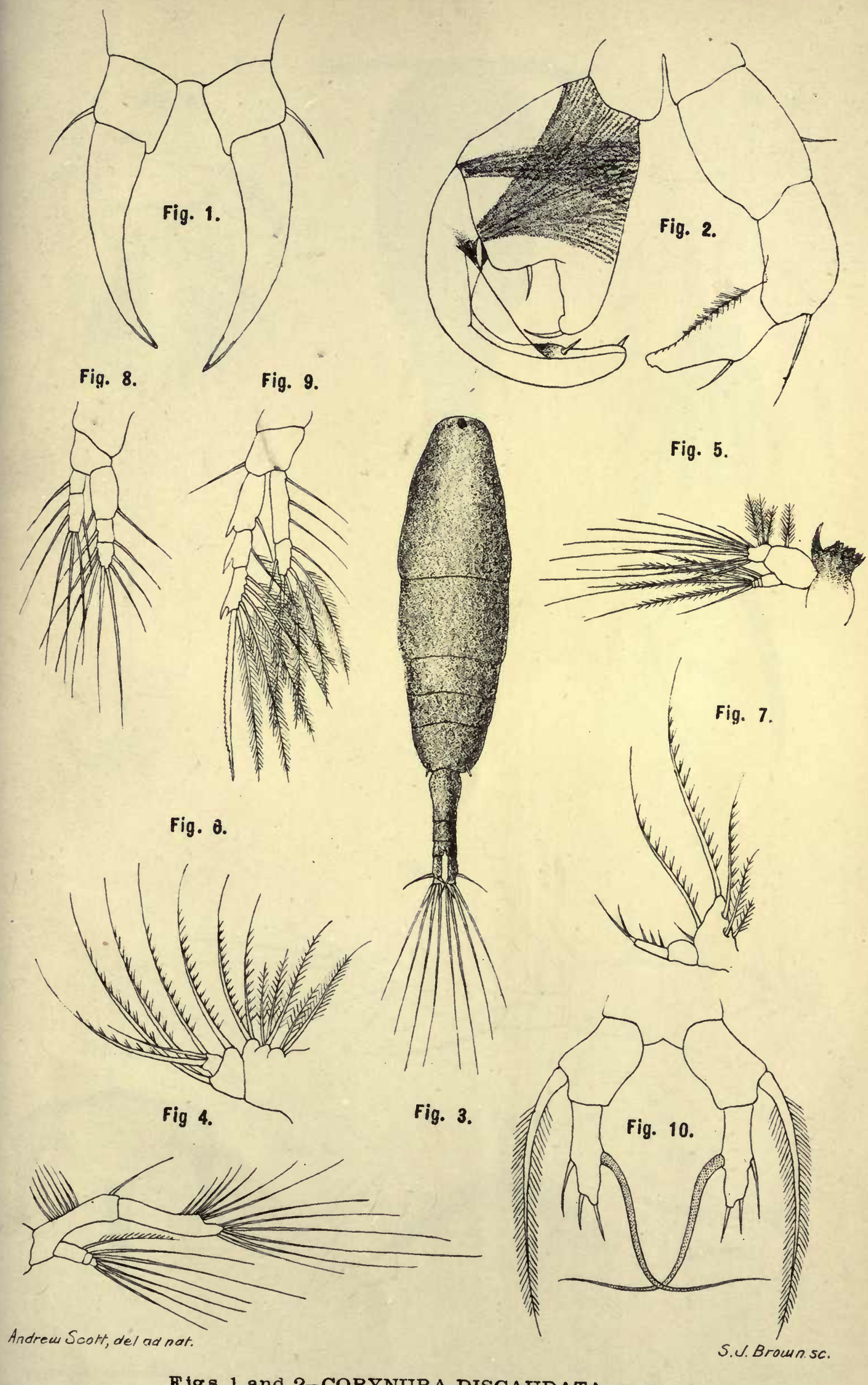
WEISMANN.

LISTER.

HERDMAN.

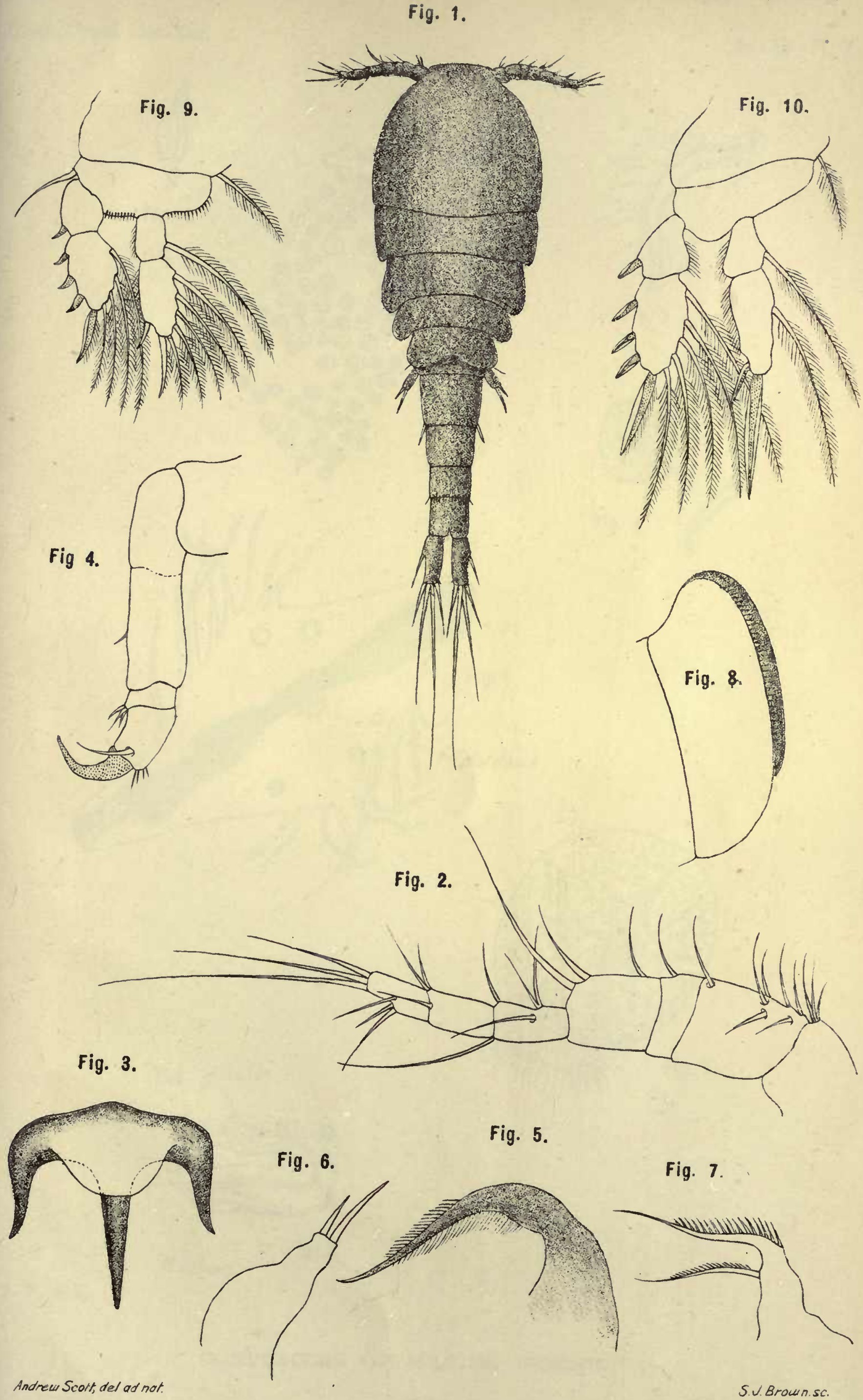


EURYTEMORA HERDMANI. n. sp.



Figs. 1 and 2—CORYNURA DISCAUDATA, n. sp.

Figs. 3 to 10—ACARTIA FORCIPATA, n. sp.



Andrew Scott, del ad nat. *S.J. Brown sc.*

PSEUDOLICHOMOLGUS COLUMBIÆ, n. sp.

Fig. 1.

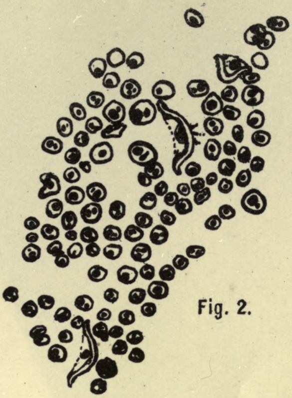


Fig. 2.

Fig. 3.

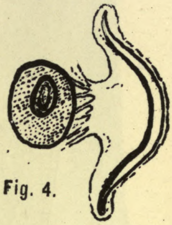


Fig. 4.

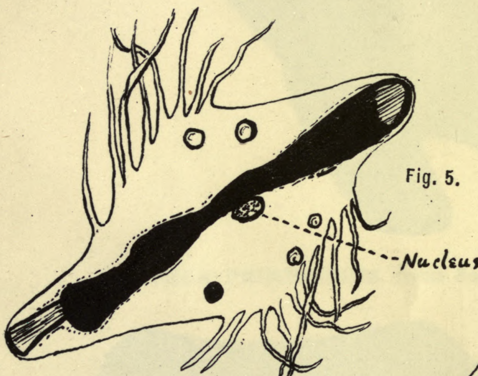


Fig. 5.

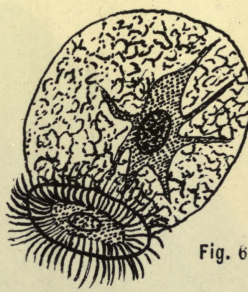


Fig. 6.

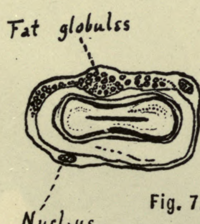


Fig. 7.

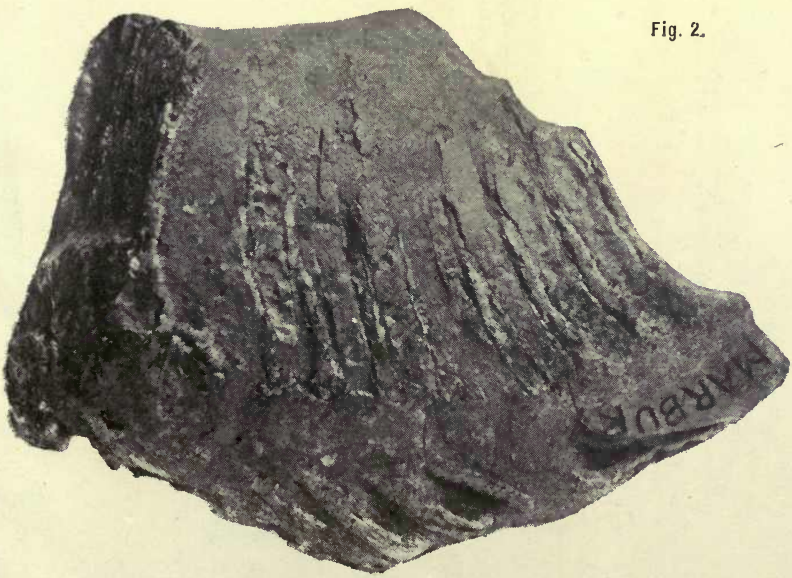
L. J. P. del.

CORPUSCLES OF MARINE WORMS.

Fig. 1.

ELEPHAS PRIMIGENIUS, from Sandbach. *Half natural size.*

Fig. 2.



ELEPHAS PRIMIGENIUS, from Marbury. *Half natural size.*

Fig. 1.

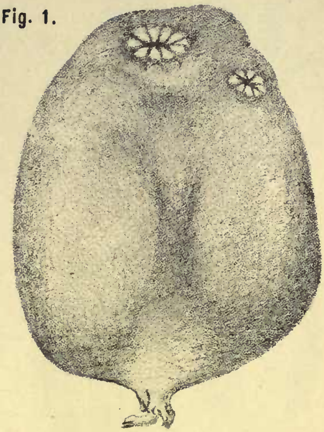


Fig. 4.

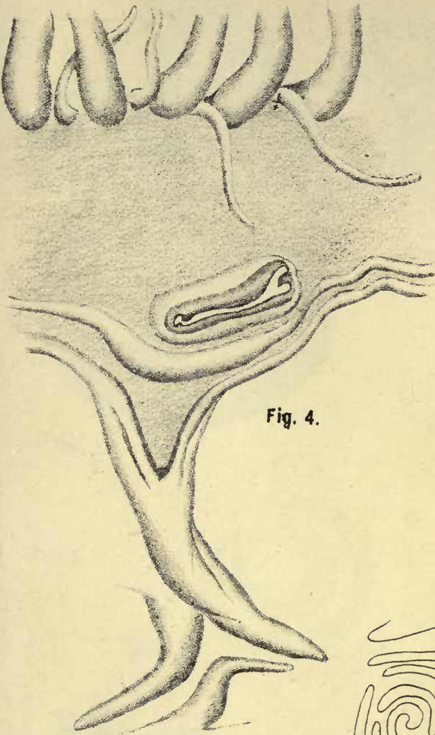
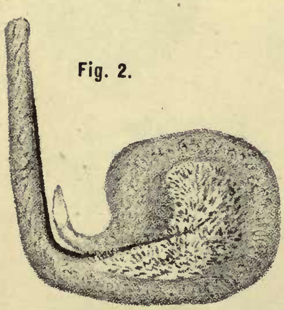


Fig. 3.

Fig. 2.



W. A. H. del.

CORELLA WILLMERIANA, n. sp.

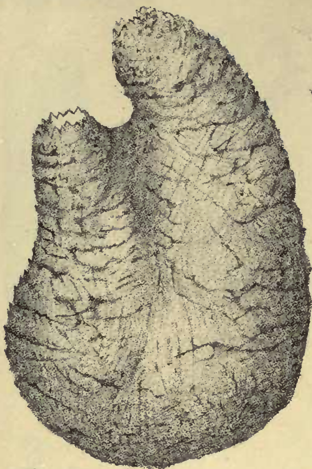


Fig. 1.

Fig. 2.

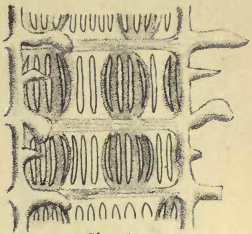


Fig. 3.

Fig. 4.

Fig. 5.

Fig. 9.

Fig. 10.

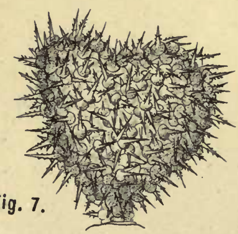
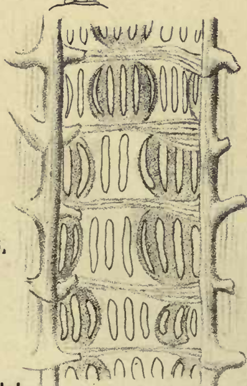


Fig. 7.

Fig. 8.



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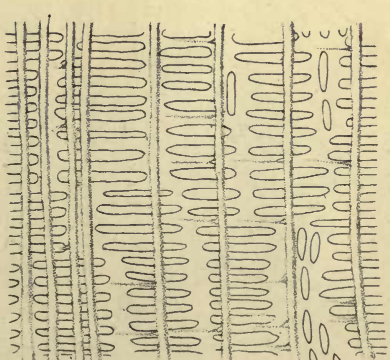


Fig. 11.

W. A. H. del.

Figs. 1-3.—ASCIDIELLA GRIFFINI, n. sp.
Figs. 4-6.—ASCIDIELLA INCRUSTANS, n. sp.
Figs. 7-11.—CYNTHIA VILLOSA, Stimp.

Fig. 1.

Fig. 2.

Fig. 9.

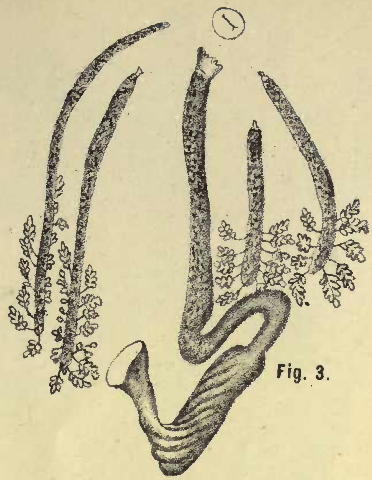


Fig. 3.

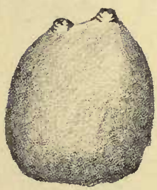
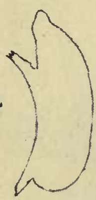


Fig. 5.

Fig. 4.



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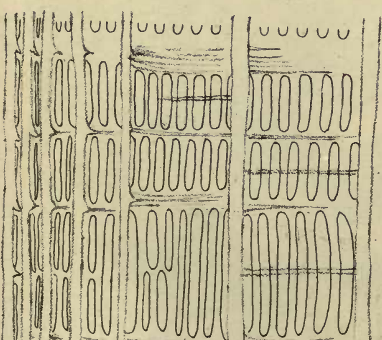

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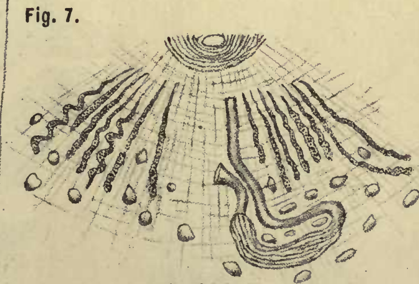
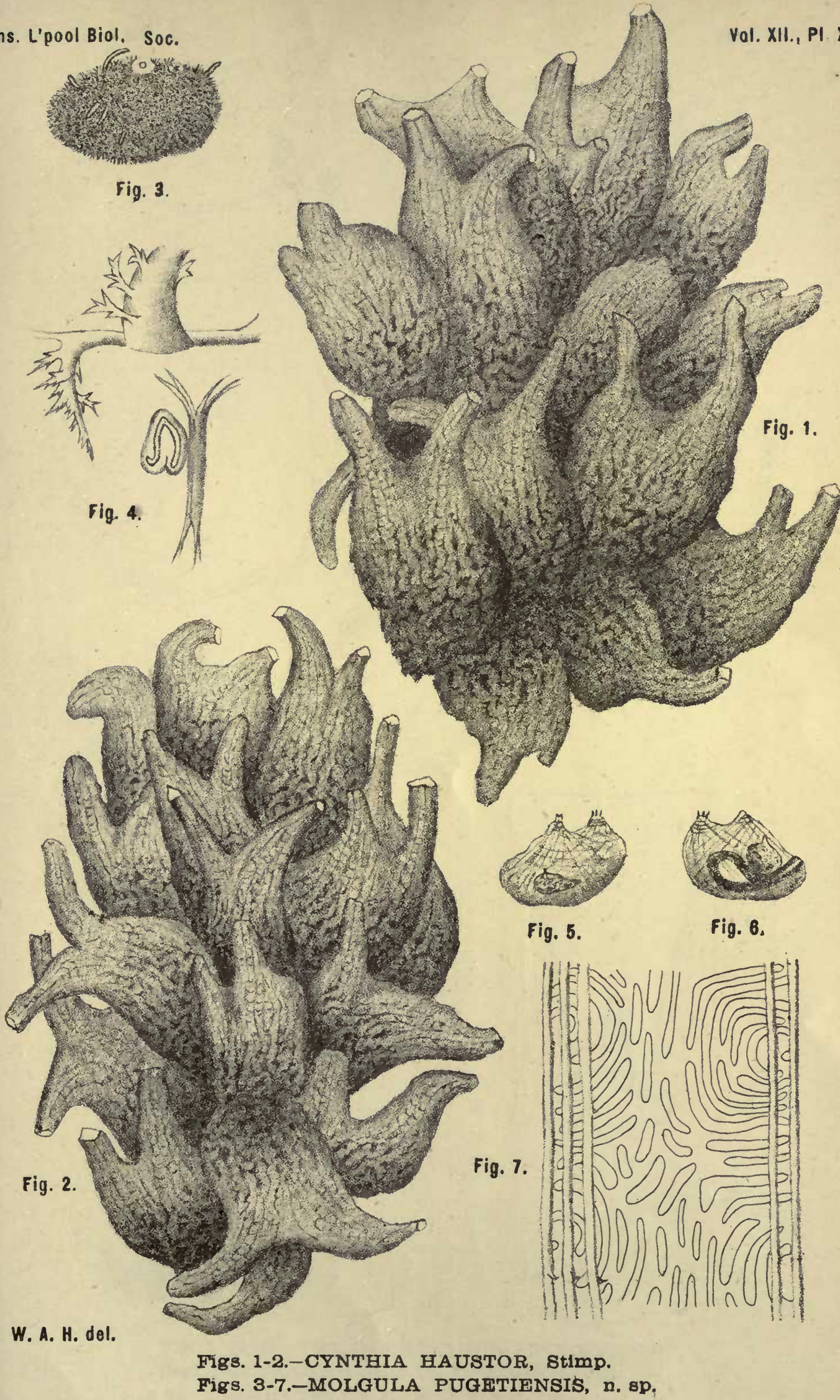


Fig. 8.

W. A. H. del.

Figs. 1-4.—STYELA GIBBSII, Stimp.
Figs. 5-9.—STYELA JOANNÆ, n. sp.



Figs. 1-2.—CYNTHIA HAUSTOR, Stimp.
Figs. 3-7.—MOLGULA PUGETIENSIS, n. sp.

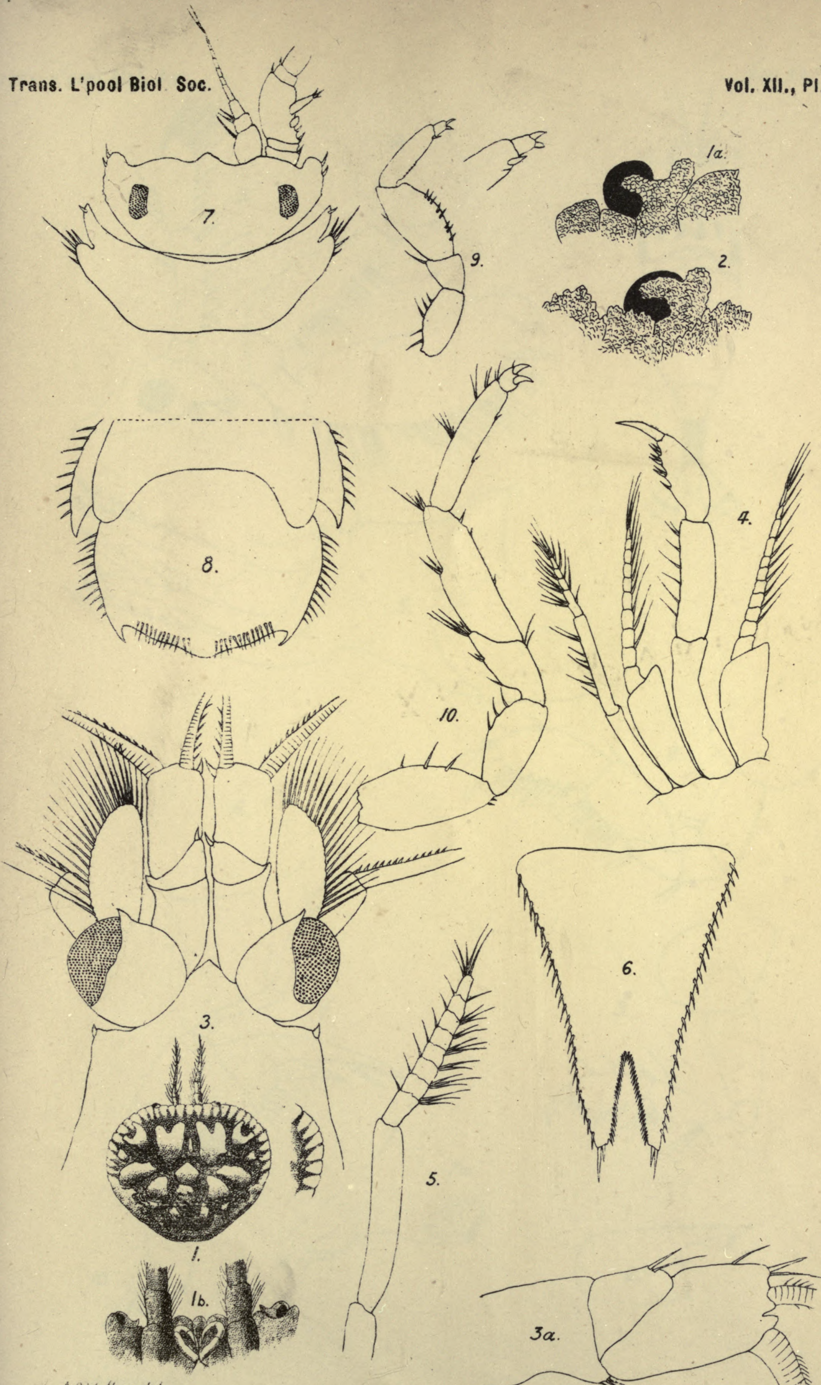


Fig. 1, 1*a*, 1*b*.—TRICHOCARCINUS RECURVIDENS.
Fig. 2.—TRICHOCARCINUS OREGONENSIS.
Fig. 3-6.—HETEROMYSIS ODONTOPS.
Fig. 7-10.—JANIRA OCCIDENTALIS.

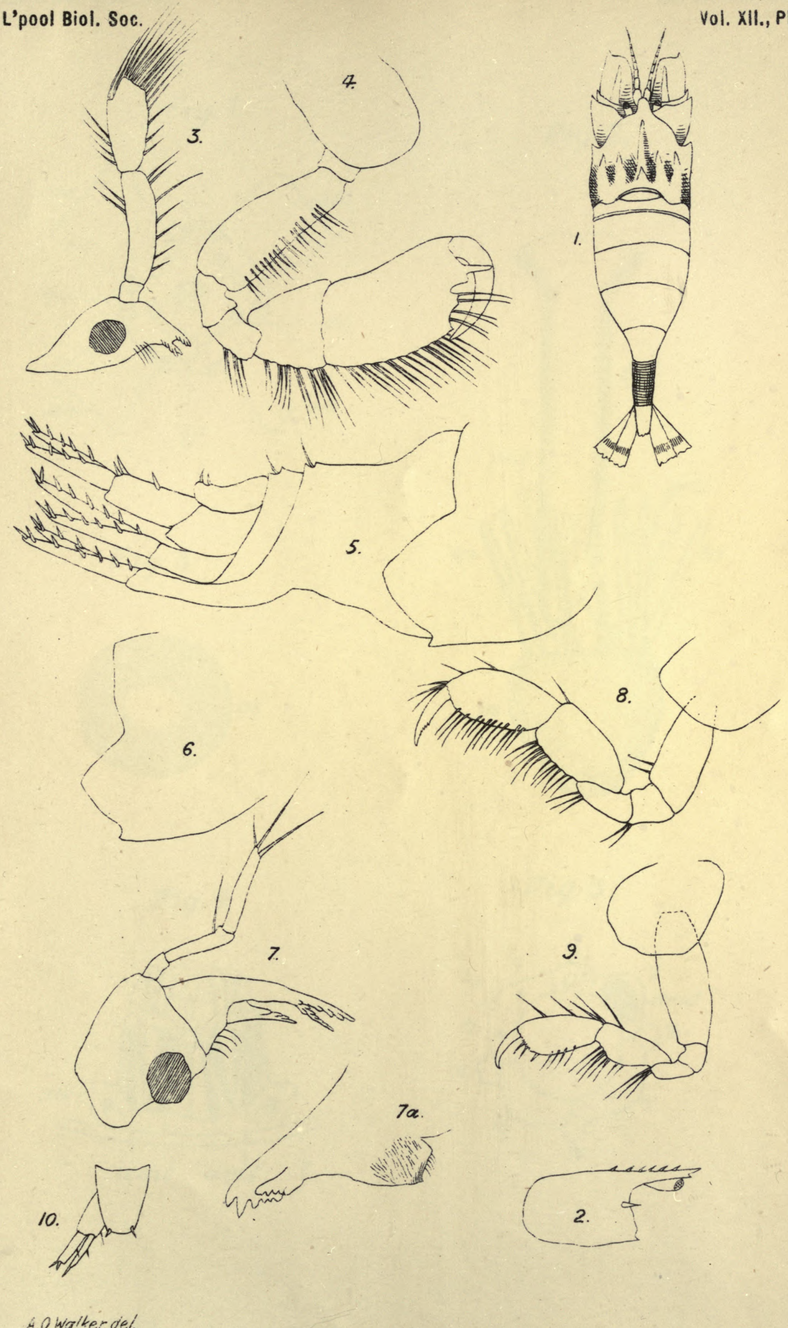


Fig. 1.—CRANGON MUNITELLUS.
Fig. 2.—SPIRONTOCARIS HERDMANI.
Fig. 3-6.—MÆROIDES THOMPSONI.
Fig. 7-10.—AOROIDES COLUMBIÆ.

Fig. 1.

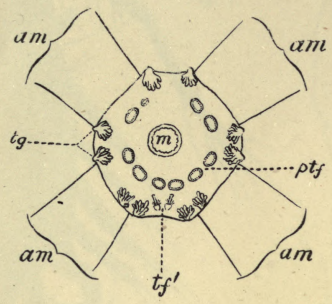


Fig. 2.

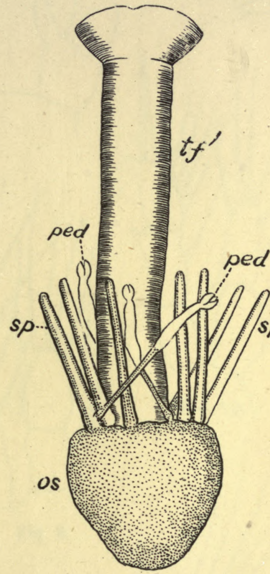


Fig. 3

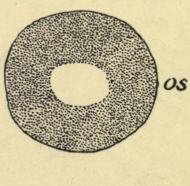
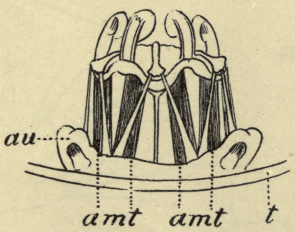


Fig. 4.



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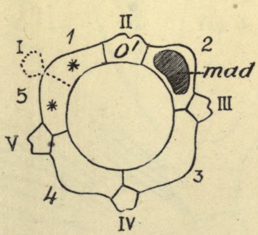
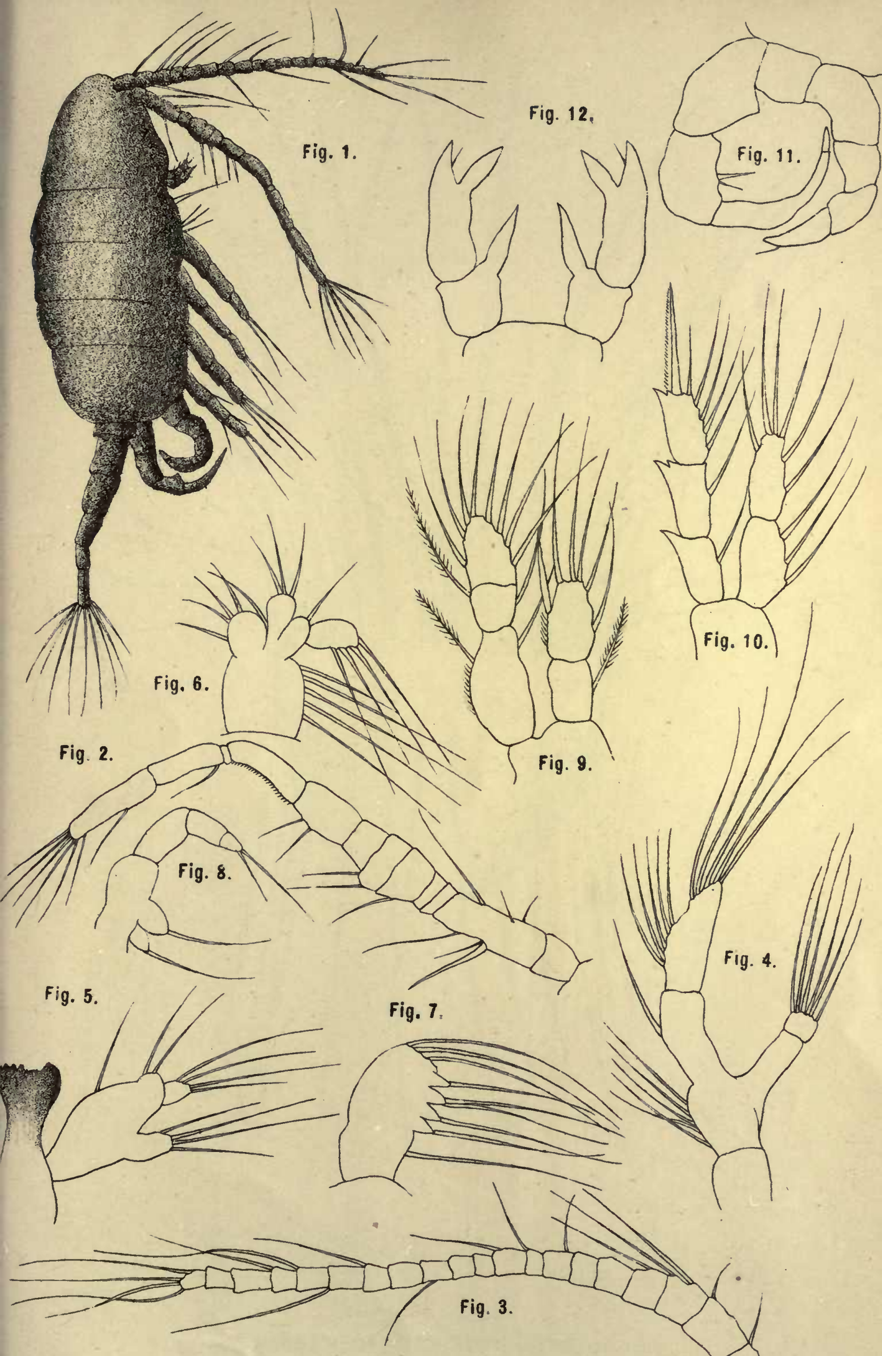
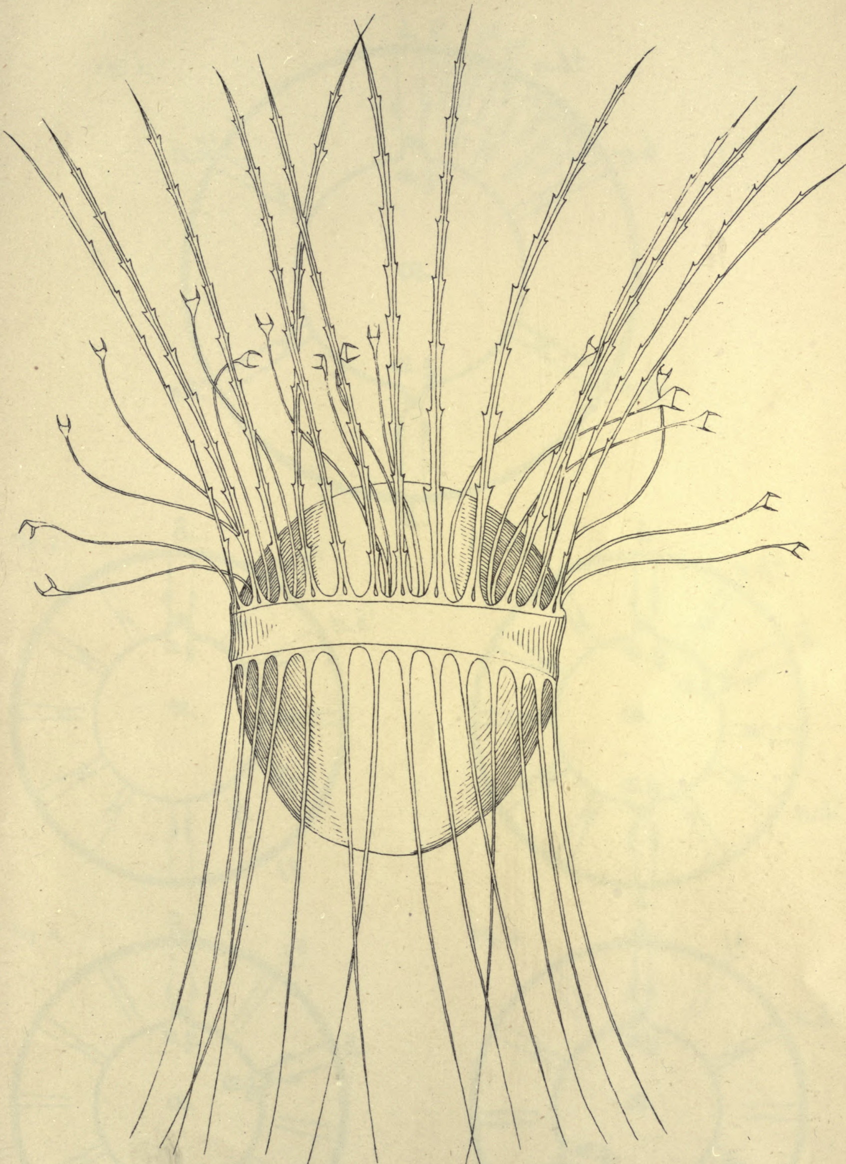


H. C. C. del.

TETRAMEROUS ECHINUS.



PARACARTIA ANTARCTICA, n. sp.



T. Comber del.

CORETHRON UNGUICULATUM, n. sp.

Fig. 1.

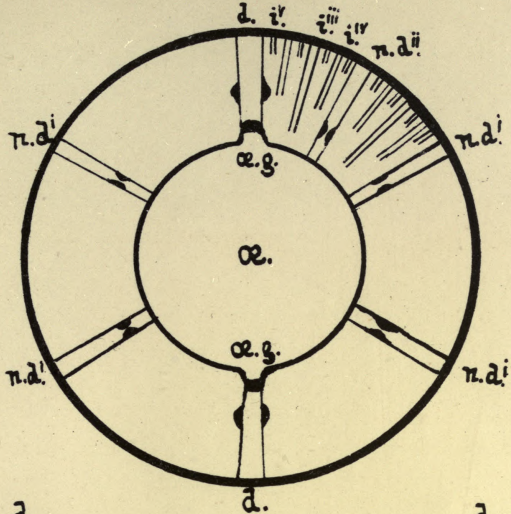


Fig. 2.

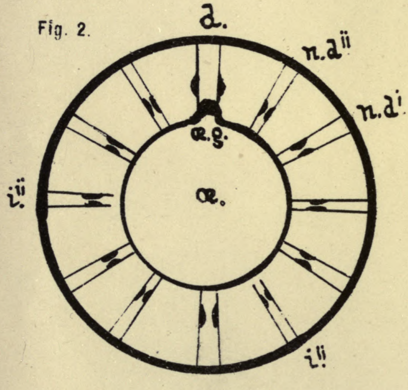


Fig. 3.

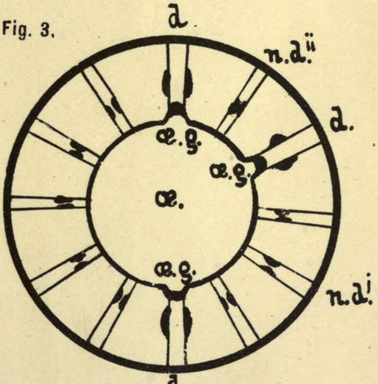
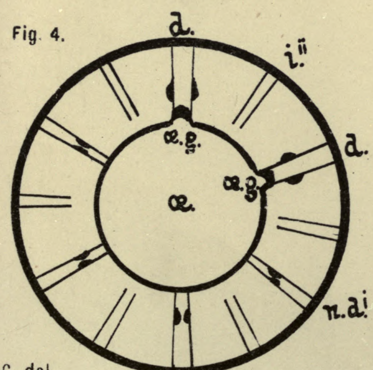


Fig. 4.



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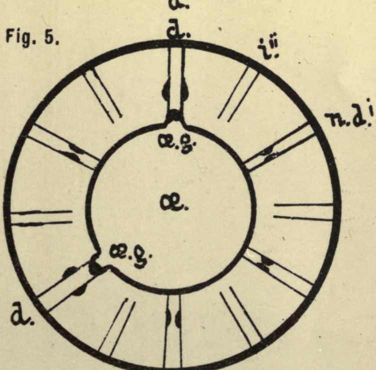

J. A. C. del.

ACTINIA EQUINA, Linn.